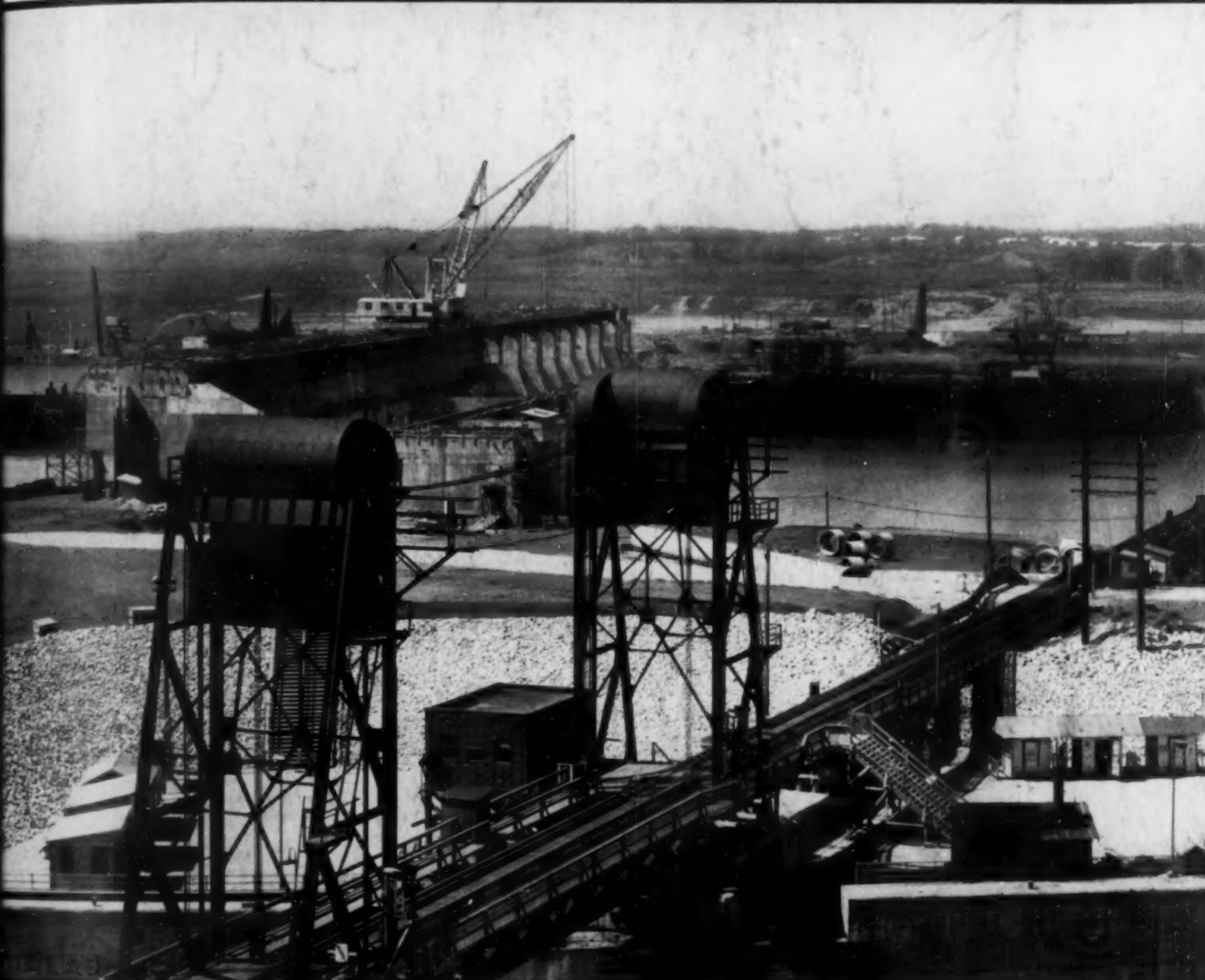
CIVIL ENGINEERING

Published by the American Society of Civil Engineers



General View of Kentucky Dam and Power House
Railroad Location in Foreground and West Embankment Site in Right Background (See Article, Page 423)

Volume 12 AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 8*

AUGUST 1942

Something to Think About

A Series of Reflection Comments Sponsored by the Committee on publications

The Faith of the Engineer

Abstracted from an Article, "Religion in the Engineering Profession," in "The Christian Register—Unitarian"

By Arthur E. Morgan, M. Am. Soc. C.E.
President, Dayton-Morgan Engineering Company, Yellow Springs, Ohio

KIPLING'S poem, "The Sons of Martha," is a good expression of the religion of the engineer:

The sons of Mary seldom bother, for they
 have inherited that good part;
But the sons of Martha favor their mother
 of the careful soul and the troubled heart.

* * * *

It is their care through all the ages to take
 the buffet and cushion the shock.
It is their care that the gear engages; it
 is their care that the switches lock.

The Engineer Serves, But Does Not Judge.—In his professional work, the engineer is concerned less with an ultimate philosophy of life than with ways for making practical life more effective. The public utilities which he created and which he operates are typical of his attitude. The railroads do not look into the morals of their passengers. The man who boards the train may be saint or sinner, Christian or pagan, friend or enemy. The railroad is a "common carrier," taking all who come, unless the law of the land has made regulations to the contrary. The water system the engineer builds carries water to church or gangsters' hangout; the electric system serves all alike.

It is characteristic of the engineer that he helps to provide the ways and means of life without pretending to dictate how they shall be used. He generally accepts prevailing appraisals of value. In America he makes munitions to save democracy. In Germany he makes munitions to destroy democracy. The minister of the gospel who unquestioningly accepts the current appraisal of ethical values may be betraying his calling. Usually the engineer is society's instrument, not its guide.

The engineer is orthodox or heterodox, Catholic or protestant, or unchurched. His profession seems not to have made him predominantly theistic or agnostic. If anything, it has made him indifferent to philosophical and theological concepts.

He Has a Religion.—Yet he does have his peculiar religion. The very nature of his work has influenced the character of this practical religion, and his engineering education has emphasized that character in certain respects.

The primary tenet of the religion of the engineer is integrity in the execution of his work. No profession fully maintains its ideals. Yet I doubt whether any other profession has so nearly approached this goal. Conscientious and responsible execution of the job at hand has been characteristic of the engineering profession. The number of bridges that fail is very small. Only very rarely does a dam give way. The engineer believes that no prestige, no piety, no personal influence, will sustain his structure as actually built. The engineer has very seldom failed in fiscal integrity. He is constantly in a position to receive special favors, and his record for resisting such temptation is very high indeed.

The engineer's ethical weaknesses are as characteristic as are his strong points. Quite generally he has felt justified in designing and building whatever someone will pay for. Seldom does he decline to do a job because he does not consider it socially useful, unless it is technically at fault. Commonly he would refuse to build an irrigation dam if he believed there would not be water to supply it. Less often would he refuse to build a structure because in his opinion, while financially a success, it would be socially useless, and a waste of human resources.

Reflects Prevailing Social Judgments.—The engineer tends to reflect, somewhat uncritically, the social attitude of his employer. When most utilities were privately owned, electrical engineers were strongly against public ownership. With occasional exceptions, one will find that the engineering employees of publicly owned utilities as strongly approve of public ownership and operation. Loyalty to the philosophy of one's employer or client often prevails over objective judgment. In the matter of professional ethics the engineer has done rea-

sonably well. Only rarely does he undermine or conspire against a fellow professional.

The Engineer's Dilemma.—His code of ethics generally has assumed that he is an independent professional man in private practice, whereas in fact he is more and more coming to be a man working on a salary for a great public or private organization. This contradiction has brought great uncertainty and confusion to his standards of professional ethics. By and large he is even less than formerly a determiner of policies; he has become an executer of other men's policies.

When a great corporation orders him to do something which contravenes his standards of propriety, what can he do about it? He may risk trying to persuade the organization to change its ethical basis of action. To do so is dangerous. He can resign his position, with risk to his livelihood, or he can acquiesce and take orders.

In this respect—in the matter of ceasing to be an independent self-directing person, and of becoming a very small element in a vast social organization—the engineer is in the same boat with the rest of his countrymen. What then becomes of the old-line ethics which largely assumed independent direction of personal affairs? This is a general problem of modern life which as yet is not being very effectively faced. In his present status, what can the engineer do to define and to maintain a high quality of ethical action?

Practical Ethics for the Engineer.—First, he can make sure that he does not fall below the ethical standards of the organization of which he is a part. This in itself may be no mean undertaking. Second, he can take the trouble to develop and to define his own life purpose and his ethical standards, so that his aims are clear. This again may keep his hands full for a considerable period of time.

Third, since the individual engineer may seem to be largely helpless in determining the standards under which he works, he needs the support of his profession. If distinctive professional standards are to be maintained, it must be partly through associations of engineers who together will define their standards, and who then as a body will support any member who is under pressure to violate such standards. Efforts to maintain professional standards through professional organizations are not without their dangers. A professional association may become partisan rather than objectively ethical.

Up to the present, engineering organizations have been largely of two types. There are the professional societies of the élite, who to a considerable extent have maintained the legend of being independent practitioners or responsibility-sharing executives; and there are the organizations of younger men whose concerns have been with licensing legislation, with wage conditions, and with other matters not greatly different from the interests of the labor unions. The question of how to define and to maintain distinctive ethical standards in relation to the world at large, in a highly socialized world such as that of the present—that issue is far from being defined or settled.

Thus we see that under present-day conditions, in that part of his life which relates directly to his profession, what might be called the engineer's professional religion is in a state of flux, and very decidedly lacks clear definition. In that the engineer is typical of the age.

Fourth, no matter how much progress may be made by engineering associations in defining ethical standards and in supporting individual members in maintaining them, the element of personal ethical responsibility will remain very large. In the end the engineer must be prepared to pay the price of living by his standards. It rests ultimately on him personally whether he will participate only in work which in his opinion has genuine social worth, and whether in times of pressure he will continue to live by his own system of values and his own convictions.

Ethical Strategy.—Only by forethought, self-discipline, and deliberate preparation can the engineer be greatly successful in living by his deepest convictions. He must make the effort necessary to develop his own philosophy of life and his own set of values. Then he will plan the strategy of his life with the aim of being able to live by that philosophy.

He will live well within his means, and will create an economic reserve for time of need. He will live simply, so as not to become a slave to ease and comfort. He will search for places to work where his purposes can be maintained. He will maintain numerous contacts, so as to have a range of choice in case a change of work is necessary. He will endeavor to be so dependable and skillful that his competence will weigh in his favor. And then, if all this preparation should fail to protect him, he will have the stamina to sacrifice his security for his convictions. That is the hard way of character and conviction in any society and in any age.

Limitations of Education.—In dealing with physical materials the engineer is a realist. He does not expect prayer to sustain a dam if its structure is inadequate.

Yet engineering education has been sadly narrow. Technical preparation for the sound and responsible practice of his profession has been so exacting of the engineer's time and effort that it has received almost his entire attention. His philosophical capacity, if he ever had any, has largely atrophied, and he lives in the world of the material present, largely unaware of the vast implications of the sheer realism of his work, and too largely insensitive to intangible cultural and spiritual values. In this, too, he is typical of the time.

Any effort to picture the general characteristics of a profession must do violence to many individual cases, and persons who individually are misrepresented may be keenly aware of the discrepancy. The resulting picture will be representative of the profession as a whole only to some degree. Any statement of the shortcomings of the engineer merely serves to emphasize the distinctive shortcomings of the times. By the creation of modern technology the engineer has set the stage for a new, more socialized, and more complex society; and now, like the rest of mankind, he is at a loss to know how to play his new part on that new stage.

E. B. Black
President
George T. Seabury
Secretary
Sydney Wilmot
Editor in Chief and Manager of Publications
Donald D. King
Art and Production
Don P. Reynolds
Assistant Editor
Volume 12

CIVIL ENGINEERING

August 1942

Committee on Publications
Clifford G. Dunnells
Chairman
George W. Burpee
Ernest E. Howard
Lazarus White
Ralph B. Wiley
W. L. Glenzing
Advertising Manager
Number 8

Soils Engineering at Kentucky Dam

By M. N. Sinacori, Jun. Am. Soc. C.E.

Associate Materials Engineer, Kentucky Dam, TVA, Gilbertsville, Ky.

Stretching some 7,000 ft across the bed of the Tennessee River, 22 miles above its junction with the muddy Ohio, the Kentucky Dam will become a member of that vast system of structures for navigation, flood control, and power constructed under the TVA. The main river dam, of the straight-gravity type, will require 3,000,000 cu yd of earth fill in its rise above the river bottom. Mr. Sinacori describes the selection and control of the fill material from borrow pit to final compaction in this mountain of earth. Of special interest is the close correlation that was found between predicted and measured fill behavior.

Location of the enormous amounts of earth necessary to build the embankment of the Kentucky Dam to an average of 65 ft above the original river bottoms required extensive investigations of possible borrow pit areas. Foundation conditions, too, were examined thoroughly to determine design, excavation, and embankment methods, and working schedules. The three embankment sections, as shown on the general plan, Fig. 1, are separated by the two reinforced concrete sections, namely, the lock and the power house and spillways.

Borrow material available for the rolled fills was essentially an ungraded silty river clay. Investigation of large areas of these variant soils required extensive use of a few simple classification tests that could be performed in quantity in a short time. Following these tests available materials were classified so that more elaborate and time-consuming tests could be made on representative samples.

Foundation investigations followed similar procedure to determine the following: (1) total amount and rate of settlement due to the superimposed weight of the embankment sections, (2) shearing strength and factors of safety against failure at all points under all conditions of loading, (3) expected rates of flow through the different types of material making up the foundation, at the increased head caused by filling of the reservoir.

MANY SAMPLES REQUIRED FOR CLASSIFICATION

Sampling operations consisted of two parts: first, the drilling of preliminary auger holes at intervals throughout the area, mainly to furnish general information on the types of materials to be found and to obtain samples used for a general classification of the different soils available; and second, the taking of numerous undisturbed samples representative of all these types of materials. These auger borings were supplemented by information obtained from window-trap samples and wash borings using drills in connection with rock explorations.

To determine the general character of the soils encountered, these routine tests were made from preliminary borings and samples:

1. Field visual classification
2. Natural moisture content
3. Atterberg-limit tests
4. Mechanical analyses
5. Specific gravity

Types and profiles of the available material found in the foundations were then established. From each type numerous undisturbed samples were obtained for laboratory tests. These were mainly tube samples, 3-in. in diameter, but wherever possible, large samples (1 cu ft) were cut by hand. The least amount of disturbance in tube sampling was obtained by having a brass shimstock liner, split only on one side, placed inside of the split sampling tube barrel. These samples were taken by means of a rapid continuous hydraulic drive. The laboratory tests on these undisturbed samples for consolidation, shear, and permeability, were made soon after the sampling.

BEHAVIOR OF FOUNDATION DETERMINED FROM TESTS

Consolidation tests were used to determine the expected amount and rate of settlement in the foundation. In these a series of increasing vertical loads are applied to the samples and for each load the rate and amount of consolidation are recorded, allowing time for complete consolidation before the next load is applied.

These data, when computed and plotted, gave the relation between the voids ratio and the load for any soil tested. From these and the field data, a curve showing the expected amount of settlement in the foundation was prepared.

To determine foundation stability, shear tests were made by applying a horizontal shearing load to a sample already under the action of a vertical consolidating load.

General View of Switchyard Slope and Lock Entrance

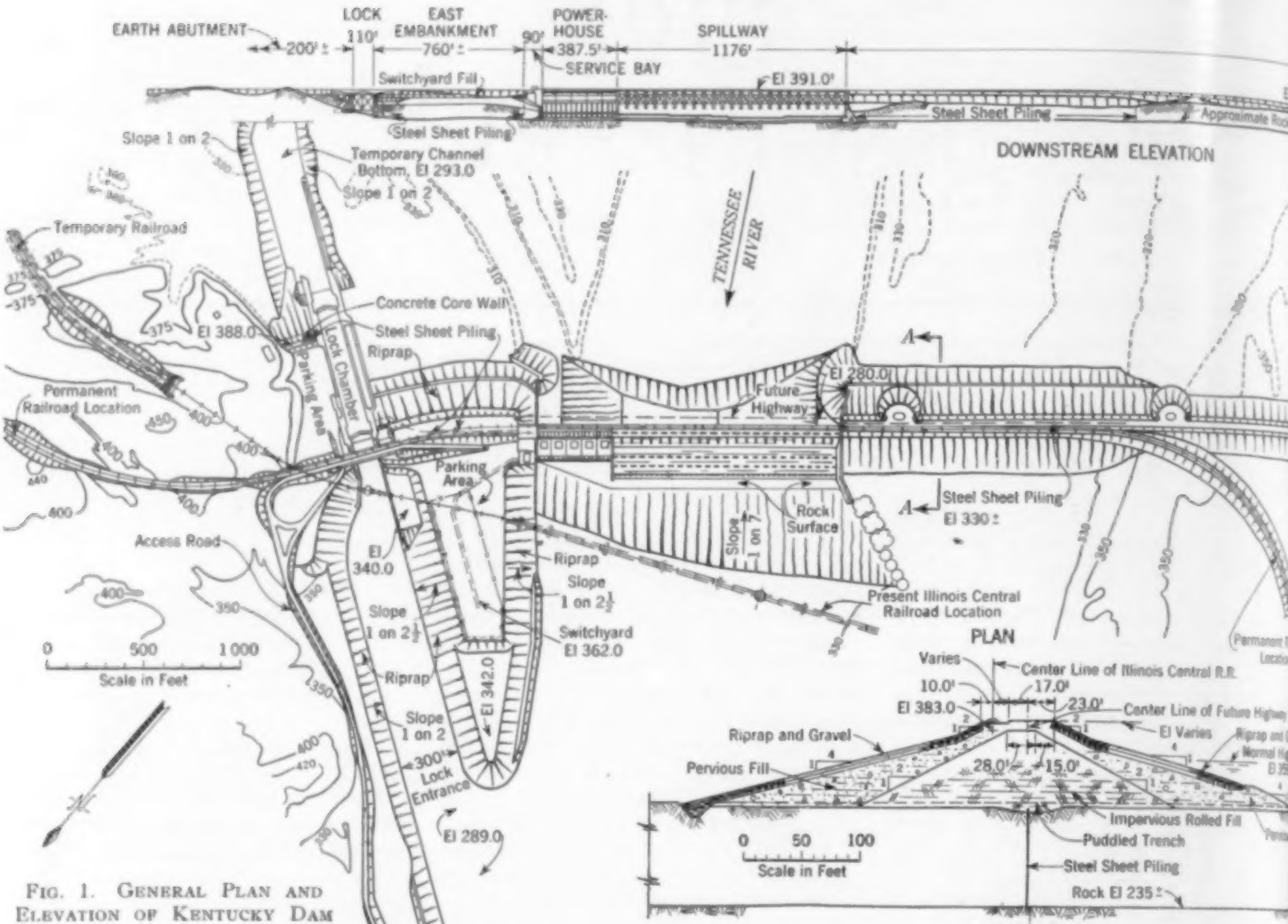
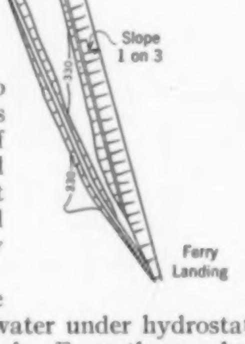


FIG. 1. GENERAL PLAN AND ELEVATION OF KENTUCKY DAM



The relation between these two loads at the point of failure gives the shearing strength. Slopes of the cuts and fills were determined from these tests so that no part of a foundation would be stressed above its strength, nor would any slope be unnecessarily flat.

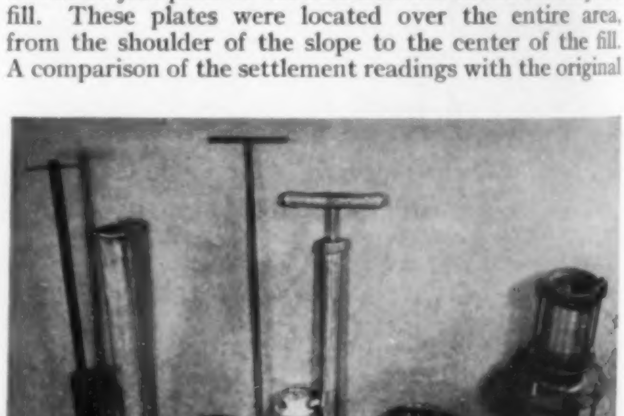
Permeability tests were made to measure the rate of flow of water under hydrostatic heads through the material tested. From these values, and the available profiles and dimensions, flow lines for the tentative designs were plotted to establish the position of seepage lines, line of saturation, direction and velocity of flow through each section, and possible piping action or excess flows.

Underlying some 20 ft of brown silty clay, the foundation profile for the east bank of the river is characterized by the presence of a soft blue silty clay 20 to 25 ft thick. The upper half of this layer is very soft and sticky, but the lower half is more sandy and is interspersed with very thin sand stringers and lenses. These stringers increase in number with depth, being from 2 to 8 in. apart. The layer finally grades into sand and then gravel, above a residual chert blanket covering the rock.

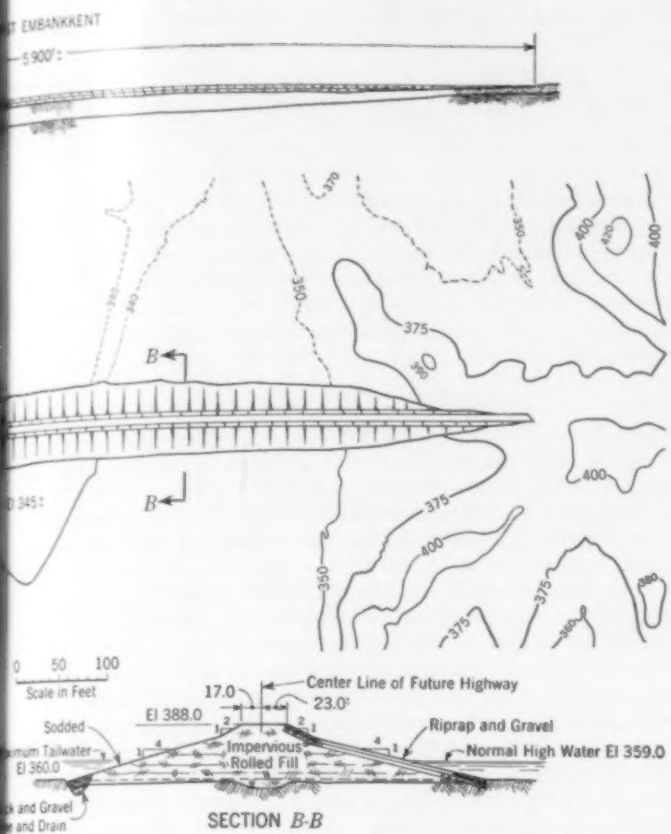
OPPORTUNITY TO CHECK PREDICTIONS

Downstream from the dam, between the lock channel and the east bank of the river, is a triangular peninsula some 2,000 ft long, starting at the east embankment between the lock and the power house. This is to be a switchyard area. The average original ground surface was at El. 326. As this area was being built up to the required El. 362 while the slope for the navigation channel was being cut, an excellent opportunity to check settlement analyses with actual readings taken in the field was offered. During cutting of the slope on the channel side of the fill it was also possible to cut by hand better "undisturbed" samples of the 1-cu ft size.

Settlement plates were set at the original ground elevation just prior to the construction of the switchyard fill. These plates were located over the entire area, from the shoulder of the slope to the center of the fill. A comparison of the settlement readings with the original



FIELD COMPACTION AND CONTROL EQUIPMENT



settlement analysis showed close agreement between these two sets of values. The actual settlement curves showed slightly greater initial settlement than the computed values, but their slope was a trifle flatter. This small discrepancy might be due to the uneven distribution of the sand stringers in the blue clay layer, or possibly to the secondary time effects in the consolidation of the soil samples, which were not taken into consideration.

Stability analyses made for the slope on the channel side showed that there would be an unstable condition in the blue clay layer if the needed final slope were cut too soon after the switchyard fill was built, with no time allowed for any consolidation in the blue clay. Pore pressure cells were installed in this layer to measure the hydrostatic excess present in the pore spaces. Pore pressure readings were made from time to time and, with proper corrections, agreed exceptionally well with the computed pressures. The final slope was cut some time after the pore pressure readings showed all sections in the foundation to be safe.

With the foundation investigations covered, we turned to the problem of securing suitable material with which to build the embankments. Preliminary tests were the same used for foundation soils. The compaction test gives the relationship between density and the moisture content. In compacting a soil with the same amount of energy expended, the addition of water increases the density obtained up to a certain value, beyond which increased water gives lower densities.

The tests were made by compacting each soil layer with 25 blows of a 13-lb hammer dropped 12 in. This was consistent with results obtained from a certain number of passes with the available sheepsfoot rollers.

Because of the presence of a large percentage of the silty particle sizes in all the available borrow pit materials, these soils are difficult to compact, and give only a narrow range of moistures on the wet side of the compaction curve within which field compaction could be obtained without excessive rolling. Also, since the natural moisture content in soils is much higher than the optimum, the limits of moisture and the corresponding densities for each type of soil had to be determined closely. With compaction, this type of material becomes quite impervious.

Triaxial Tests Measure Pore Pressures

In determining the shearing strengths of the compacted material, the triaxial compression test was made in addition to the direct shear test. In the triaxial test the induced pore pressures can be measured and the necessary corrections made. These pore pressures are that part of the load transmitted through the soil mass, but actually carried by the water found in the pore spaces.

From the data obtained, the induced pore pressures were computed and the final shearing load was corrected for this excess pressure. For a complete test, this entire procedure was repeated several times, using a newly prepared sample and a different hydrostatic pressure each time, until a relation between the net shearing loads and the hydrostatic pressures was obtained.

The values of permeability, shear, and consolidation for the borrow material, obtained first as compacted and then after saturation, were then integrated with the compaction densities and moistures, and limits of minimum and maximum values of the established design were determined. These limits of moistures and densities for each group of material to be used in the embankments were the basis for the field control during construction.

The borrow pit for the west embankment is located immediately upstream from the axis of the dam. This entire area consists of a deposit of silty clay of from 10 to 20 ft thick over a layer of sand which grades into gravel above the deep rock and extends laterally under the earth dam. In determining the quantity of borrow material in this area, due consideration had to be given to the thickness of blanket needed over the sand layer in order to hold the seepage through the foundation to a minimum.

The graphical analysis made for the west borrow pit and foundation, by the method of flow nets, was modified to include the various types of soils—blanket clay, sand, and gravel layers—each infinite in extent in the upstream

Backfill Next to Power House Service Bay Wall, East Embankment

TRENCH FOR WEST EMBANKMENT, WITH SHEET-PILE CUTOFF

direction, but of widely different permeabilities. The thickness of the impervious blanket left in this upstream area depended on the seepage expected and on the elimination of any possible piping action due to local high velocities. Analyses showed that a minimum thickness of blanket varying uniformly from 10 ft at the downstream edge of the borrow pit to 5 ft at a point 1,000 ft upstream from this edge, with a 5-ft minimum from there on upstream, would give the required protection against excessive seepage and furnish the needed short-haul material for the earth embankments.

CONTINUOUS CONTROL NECESSARY IN FIELD

As each section of borrow pit was laid out immediately ahead of the excavation, field compaction tests and natural moistures were taken to check the available soil profiles and to establish the current values of moistures for each type of soil to be used. Following the haul, field compaction tests were made at regular intervals of time, and with every change of material coming into the fill, in order to check the densities and plasticity needle readings expected after rolling. For sheepsfoot compaction, the soil was spread into layers of an even thickness. The thickness of this layer was determined in the field for all materials, and was such that it would give an evenly compacted density throughout the layer for the required amount of rolling. To break up all lumps in the soil and to help in distributing more thoroughly any water that might be added to the fill, disk rollers were used following the spreading and just ahead of the compacting rollers.

The densities obtained after rolling were checked with a plasticity needle gun, making use of the relation between the compacted densities and the needle readings obtained from the laboratory-prepared control curves for each type of soil. The plasticity needle gun used has an oil chamber to transmit the pressure from the handle to the needles. A pressure gage with an adjustable dial is connected to the oil cylinder to measure the pressures. The needles used have ellipsoidal heads and stems 6 and 8 in. long, made to penetrate the whole layer.

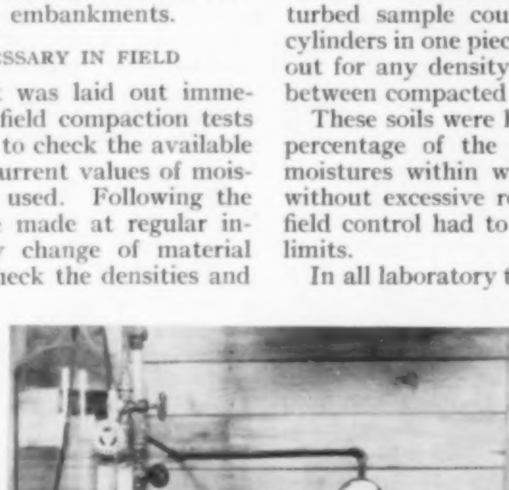
This gun has shown several advantages over the standard spring type. The elimination of the relative motion between the handle and the needle makes it easier for the operator to push the needle into the fill at a constant velocity. Any variation, with depth, in the resistance to penetration is registered directly on the pressure gage and noted by the operator. Such a variation would be checked further for uneven compaction in parts of the layer. From time to time undisturbed samples of the fill were taken to check the densities against the plasticity needle readings and moistures.

USE OF SIMPLIFIED FIELD CONTROLS

Mechanical analyses on these borrow pit soils showed that the average consisted of 5–15% sand, 50–60% silt, and 30–40% clay. It was classified on trilinear charts as a silty clay. The predominance of the finer silty and clayey particle sizes made the use of our plasticity needle guns for direct field control desirable and accurate. The cylinders used for checking field densities caused very little distortion or swelling during sampling. By actual comparison this method proved to be more accurate than the calibrated sand or oil methods, or the submerged weighing of undisturbed paraffin-coated chunks. An added advantage was that the undisturbed sample could be pushed out of the sampling cylinders in one piece and then inspected closely throughout for any density irregularities and checked for bond between compacted layers.

These soils were hard to compact because of the large percentage of the silty particle sizes. The range of moistures within which compaction could be obtained without excessive rolling was rather narrow, and strict field control had to be maintained to stay within these limits.

In all laboratory tests for both foundation and borrow-pit soils, considerable time was saved by first classifying the entire available range of materials into definite groups. The routine classifying tests mentioned were rather simple, and a large number of them could be made within a short time. A few specific samples representative of each of these general groups were then used for the more elaborate tests, such as consolidation, shear, permeability, and compaction, to obtain the specific properties of the materials needed for the analyses.



TRIAXIAL SHEAR MACHINE ASSEMBLY

As of July 10, the east embankment fills, requiring 550,000 cu yd, have been finished and brought to grade, except for a small quantity of 20,000 cu yd needed to top the section of fill next to the power-house service bay wall. In the main west embankment fill 350,000 cu yd of the estimated 2,000,000 have been placed; an additional 1,250,000 cu yd are to be placed this summer and fall (1942); and the remainder is scheduled to be placed in the summer of 1943.

Arizona Develops Economic Highways

By W. R. Hutchins, Assoc. M. Am. Soc. C.E.
State Highway Engineer, Arizona Highway Department, Phoenix, Ariz.

Even in normal times the highway engineer is hard pressed to make his budget stretch over the wide demands placed upon it. Fortunately his standards have nevertheless been high. Thus in general yesterday's peacetime road system suffices for today's military needs—thanks to the wise foresight of the government. Arizona's problems are those of a sparsely settled state with limited resources. But they have been met economically and without indebtedness, according to Mr. Hutchins. His original paper, here condensed, was presented before the Arizona Section's 1942 Spring Meeting in Tucson.

A system of highways adequate for present-day heavy commercial traffic is adequate also for military purposes. In general the three methods of moving materials and supplies are by water, rail, and highway. These three should be considered as a whole, so that if one breaks down another will be able to fill the need. Water and rail methods are especially vulnerable. If either or both become partly useless through military action, the main source of relief is bound to be the highway. In my opinion, this transportation medium is more flexible than the other two as regards quick repair and detouring possibilities.

Let us for a moment consider highway development in Germany during the past 15 or 20 years. During this period Germany built a network of highways which can readily be classed as commercial because the cross section used was about the same as that of our high-t ype commercial routes. But, as time has proved, Germany had something else in mind. This system has served its purpose well for the quick movement of military forces. This, I think, bears out my statement that an adequate system of commercial highways is also an adequate system of military highways.

Government Aid Paces Road Planning

Back in 1916 Congress passed a law which, although no one then dreamed of today's emergency, perfectly fits into the present situation. This original act carried an appropriation to be spent under the supervision of the Bureau of Public Roads in conjunction with the state highway departments on roads called "post roads." This meant any road over which the mail might be carried. The federal government put up 50% of the cost and the states matched this with 50% from their own funds.

It was soon evident that a patchwork design of highly improved sections was being developed with bad sections in between and no definite comprehensive program. Each state and each locality chose the sections to be improved, with little thought for a connected system within the state itself, and certainly none for a nation-wide network.

This error was corrected in 1921. In each state 7% of the total rural road mileage was placed not only on a state-wide connected system but also on a nation-wide system.

It was recognized that most of the states had large areas of land within their borders that were owned or controlled by the U.S. Government in the form of parks, monuments, Indian reservations, forests, and public lands. In the case of Arizona, 71% of its land and water area is thus controlled or owned by the U.S. Government. Thus in our case the matching basis was 28% for Arizona and 72% for the federal government. This basis was further reduced by the Act of 1941, which amended the Federal Highway Act so that Arizona put up $13^1/_2$% and the federal government $86^1/_2$%. But this applied only to the strategic system, of which some is on the federal aid system and some is not.

Arizona well understands just what the purpose of this act was, in creating a nation-wide system of connected highways. One of the best illustrations is the 17-mile section across the extreme northwestern corner of our state, which serves very few of its citizens, and in no way the state as a whole. This 17-mile section, however, is on the north and south connecting highway between California, Nevada, and Utah. All the other states had built or were building their sections and this would have left a 17-mile very nearly impassable section in Arizona on a route that had hundreds of miles of good connected highway. Possibly Arizona would have put off building this section even until now because we had and still have a large unfinished mileage in the more populous parts of the state; but under the 1921 act, the then U. S. Bureau of Public Roads advised that we must build this section or no more federal aid would be forthcoming. This was as it should be, but it was pretty hard to take at the time.

On paper this gave America a nation-wide integrated system of highways. All that was needed was time and a few billion dollars to build or improve it. Up to the present there is no doubt but that some improvements have been made on practically every mile of this system. Some examples of improved Arizona roads and bridges are shown in the accompanying illustrations.

The pertinent question now under the war program is this: Are we sure that what has been done is adequate to serve this system? I would say, as a whole "Yes," but for some specific sections, "No." However, this situation is being taken care of under the usual arrangements between the Public Roads Administration and the state highway department. This does not mean that we are now building any super highways under the definition of military highways. We are building what

War Economy—Arch Culvert Is Unreinforced on New Huachuca-Nogales Highway, Arizona

BEAUTIFICATION WITH MATERIALS AT HAND
Native Planting Along Parkway North of Tucson, Ariz.

we would normally build to meet our peacetime commercial traffic demands. So there is no great mystery about it, and nothing very different between military and peacetime highway construction.

The reason the construction that has been done on this entire mileage may not altogether bring it up to the highest standards is purely economics or lack of finances. In the past few years our peacetime traffic demands have advanced by enormous strides, and in all instances the engineers fully recognized this increased demand. In many instances, however, they were overruled or forced by "Old Man Economics" to construct sections of road which would temporarily serve but which would not satisfy fully or indefinitely.

From this it is evident that owing to the foresight of authorities in Washington, we now have a system of highways covering the entire United States, very well built as a whole and adequate for peace or war. But I shudder to think what conditions would have been as to a connected system if it had not been for this coordinating law, carried out by the Public Roads Administration and the state highway departments.

PROGRESS BY REVERTING TO OLD FORMS

The evolution of highway design during the change-over from horse-and-buggy conditions to the present high-speed travel has probably been greatest, not in the actual use of materials, but in the refinements in the use of them. In early days we used cement, asphalt, steel, and creosoted timber. We still use the same materials with certain refinements and possibly broader applications. But we are not as smart as we think we are when we talk of the wonderful progress made in design and practice.

In laying a concrete pavement in the horse-and-buggy days we used wood for expansion joints; then for a period of twenty or twenty-five years we used everything imaginable, including cork and rubber. Now we have finally agreed that wood is after all the best and are specifying it today. At one time we designed joints with an intricate set of dowels, then decided to eliminate them in large part. In many ways, however, progress has been made, as for example in refinements for the control of the several ingredients that go into a concrete pavement. We get a stronger, smoother riding, more durable concrete, with less cement than before.

For structures and retaining walls we first used mass concrete. Then over a period of years we practically discarded it and substituted reinforced concrete with its remarkably thin sections and its correspondingly smaller amount of material.

Similarly with bituminous work, in the early pavements natural asphalt was used in the mix, most of it imported from Trinidad. This was a hard substance with flinty characteristics and it disintegrated quickly. The asphalts of today are obtained from our own crude oils of the West, and we are using those with a greater penetration quotient in order to avoid the tendency toward brittleness.

ALSO SOME NEW IMPROVEMENTS

The only really new type of pavement used extensively today that we did not have during the horse-and-buggy days is the thin oil road or plant-mix wearing surface locally known as "oil cake," which came into being about 1929. This light road-oil mix has practically the same aggregate specification as the old asphaltic concrete mix. So in the main we have merely taken the road-building materials and methods of yesterday and added certain necessary improvements to meet present needs.

In other words, we have not discovered anything radically new. The most outstanding improvements have been in layout—alinement, grade, slight distance, width, and curvature. This departure from earlier designs has been the result of faster vehicles and the growth of the trucking industry.

In the past few years we have had injected into highway building something that attracted little if any attention a few years back—beautification or roadside improvement. This subject can be wrapped up in a large package of individualism. I am probably old-fashioned in thinking that trees are beautiful anywhere. But the experts do not agree with me; they insist that trees should not be planted in rows, especially along the open highway, but rather should be planted in groups at certain intervals.

Roadside improvement divides itself naturally into two phases: (1) planting, and (2) treating the roadside itself as by shaping shoulders, cuts, slopes, and the transition from cut to fill. Like everything else, it rests finally upon economics or on how much the public can afford to pay for something which is very nice to have, which it wants very badly, but which it can do without.

Plant life and especially trees do best when aided by natural rainfall. For this reason Arizona is not so well adapted to roadside tree planting, since the trees will not grow satisfactorily unless watered continuously.

HIGH COST OF BEAUTIFICATION

It is very pleasant to observe and admire a modern four-lane highway bordered on each side with palms, sour oranges, and oleanders, but its yearly maintenance bill soon runs into thousands of dollars. Arizona's annual maintenance bill amounts to about $40,000. I understand that California's bill for the same type of maintenance is about a half million dollars. This is fine if it can be afforded, but a highway department's most important function is to construct highways rather than to create visions of botanical beauty.

HEAVY CONSTRUCTION MAY BE WELL JUSTIFIED
Rock Cuts on Superior Miami Highway

CROSSING OF SALT RIVER BETWEEN GLOBE AND SHOWLOW
Picturesque Steel Arch Has Span of 148 Ft $4^3/_8$ In.

GOOD ROAD PLUS GOOD SCENERY
New Concrete Pavement Between Williams and Flagstaff

…NTIAL STRUCTURE CARRIES MANY MAIN ROUTES
Concrete Arches Across Salt River at Tempe

…rizona Highways Combine Beauty and Utility

BITUMINOUS CONSTRUCTION ON MAIN HIGHWAY NEAR WICKENBURG

…LS CANYON SECTION OF SUPERIOR-MIAMI ROUTE
…Roadway Appears at Left of Central Rock Mass

MARBLE CANYON—STEEL BRIDGE OVER COLORADO RIVER NEAR LEE'S FERRY

CONSERVATION OF STEEL—24-IN. CONCRETE PIPE CULVERT IS USED NEAR FRY, ARIZ.

With this premise in mind, Arizona has stopped planting anything that will take perpetual watering to keep alive, and now limits itself to native growth such as mesquite, cactus, palo verde, or other plants needing only the care that Nature gives in the desert or mountains. These "natives," I think, are quite alluring and further they involve no maintenance expense. Incidentally this roadside improvement phase of highway construction has been entirely abandoned for the duration.

JUSTIFYING IMPROVEMENTS BY ECONOMICS

The highway engineering fraternity has worked out a theory called "highway solvency." This method of analyzing a certain section of highway or proposed highway determines whether a proposed improvement or new construction project is solvent. That is, in simple language, will the revenue earned by the section pay for the principal invested plus the maintenance?

This is a cold-blooded economic diagnosis and could be applied absolutely in the case of private corporations to improvements or additions. But the revenue collected from road users is public money and, personally, I do not think this idea can always be applied absolutely, for certainly people living in isolated areas are entitled to some consideration.

This method is applied in various ways depending upon the character of the area involved. In a congested state with maximum productive area and with large automobile registrations, hardly a section of road would fail to show solvency. But in some western states where the population and the registration of motor vehicles are small, and a large area is practically non-productive of revenue, especially to the state, it is rather difficult to make many state routes appear solvent.

So, in my opinion, the only thing to do is what we have been doing—weigh the section of road in question as to the necessity and convenience of the people being served. Then, when it is constructed, some sections in other parts of the state which are over-solvent, or rather which yield a dividend, must pay for those sections which are not solvent. In other words, perhaps the state highway system can be considered solvent as a whole, depending on a very small mileage to support the entire system. In passing I would like to say that Arizona is one of a very few fortunate states which are solvent. No money is owed on the system we now have and we could close the department tomorrow, pay off all bills, and have money left.

WAR EMERGENCY NOW DICTATES

Another problem that always faces the highway engineer is planning. No engineer wishes to expend money on construction that he knows is adequate today but will be inadequate tomorrow. This brings him face to face with the question of how many tomorrows, or years, he should plan for.

To illustrate—Arizona first made an attempt to get the main arteries covered with some type of satisfactory dustless surfacing without paying too much attention to long-range planning. This idea is still being carried out on the roads which, although not main arteries, are still in need of this type of surfacing.

Practically all main arteries have been improved, and naturally a large portion of them are now in need of reconstruction. On this work, the long-range planning is utilized, and the reconstructed sections will be built with a view to future requirements. In the case of all roads, whether or not they are main arteries, each individual section, regardless of its location, must be very carefully considered to determine what the near future seems to require. New construction on less important roads may be of just as high a type as that on the main arteries.

That we are using materials similar to those of thirty years or more ago, but that their manipulation has been vastly improved, is vividly shown in our thin sections of reinforced concrete design. But now comes the war emergency and time is turned back, for during the emergency we are designing to eliminate strategic war materials. The old gravity-type concrete walls are now being used again; concrete pipe takes the place of metal culvert for small sizes; an arch design of plain concrete (with the addition of some temperature-stress steel) replaces the larger pipe and smaller reinforced-concrete boxes; creosoted timber is used instead of the larger boxes and steel-girder bridges; and reinforced concrete girders find a place on overpasses instead of steel girders. All of this goes to show that in peace or war, fair weather or foul, a highway department must take cognizance of approaching demands and meet them with the proper treatment, whether the situation calls for horse-and-buggy methods or for the latest innovations.

WHAT THE OPEN ROAD OFFERS IN ARIZONA
Scene Between Williams and Flagstaff

Steel Bridge Design to Conserve Material

Demand for Steel by Expanded War Industry Requires Careful Analysis of Allowable Stresses

By SHORTRIDGE HARDESTY, M. AM. SOC. C.E.
CONSULTING ENGINEER, NEW YORK, N.Y.

DURING all periods of stabilized economy, it has been the aim of engineering design to produce satisfactory structures at a minimum ultimate cost. Hence maintenance and durability have directed a conservative choice of unit stresses and proportioning. An emergency may disrupt the supply of materials and change the basis for relative economy, but structures must still be designed to be safe under existing loadings and to function satisfactorily. The rational determination of structural properties for steel bridges to meet present conditions has been studied by Mr. Hardesty, as explained in this paper, originally presented before the Structural Division at the Roanoke Meeting of the Society.

BEAUTY OF SLENDER SECTIONS SHOWN BY RED-CLIFF ARCH OVER EAGLE RIVER, COLORADO

PRACTICALLY all heavy construction involves the use of steel, reinforced concrete, plain concrete, timber, or various combinations of these materials. Steel construction requires the largest tonnage of steel for a given structure, reinforced concrete a considerably smaller amount, timber still less, and plain concrete none. It is evident that steel will be conserved if reinforced concrete can be substituted for steel, and timber or plain concrete for either steel or reinforced concrete. The possibilities of making such substitutions should be studied thoroughly. There are, however, structures which depend upon the properties that steel alone possesses; and in their design special study is necessary to determine any economies that can be effected.

In laying out bridges, designers usually vary span lengths, spacing of members, and other features to produce the minimum total cost for the structure. Under existing conditions it becomes equally important to insure the use of a minimum total weight of steel, and proportions must be studied for that viewpoint also. For example, where long approaches are involved, it has been customary to change from steel spans to concrete spans or embankments at the point where the two types cost the same per linear foot. By replacing some of the steel spans with concrete spans or embankments, a considerable saving in steel tonnage can frequently be effected with but little increase in the total cost of the structure.

It is legitimate, in war time, to provide capacity only for present requirements, without considering possible future increased traffic volumes or loadings. Provision for future extension or strengthening should be made only if the cost of the present construction would not thereby be appreciably increased.

RAISING OF UNIT STRESSES PROPOSED

Evidently steel can be saved during the emergency by raising unit stresses. Various suggestions for such increases have been advanced, in percentages ranging from about 10 to as much as 50. It is the purpose of this paper to analyze current unit stresses and safety factors to determine permissible increases.

The steel bridge specifications of the American Railway Engineering Association (A.R.E.A.) and the American Association of State Highway Officials (A.A.S.H.O.) supply a guide to the limit of permissible increases that has stood the test of actual experience. Each of these specifications sets up conservative unit stresses for general design, and in addition a set of higher unit stresses for use in determining ultimate carrying capacities and maximum allowable overloads. These higher stresses are referred to as rating stresses, as contrasted with the lower design stresses. The A.R.E.A. specifications permit a basic unit tensile stress for rating purposes equal to 0.8 of the yield point, or 26,400 lb per sq in. for structural carbon steel with a yield point of 33,000 lb per sq in., as compared with a design stress of 18,000 lb per sq in.; while the A.A.S.H.O. specifications permit rating stresses $1\frac{1}{2}$ times the design stresses, or a tensile unit stress of 27,000 lb per sq in. for structural carbon steel.

RATING STRESSES PROVIDE LIMITING BASIS FOR DESIGN

Bridges stressed to the limits permitted by the rating specifications have been operated successfully; therefore, if the conditions which apply in the rating of existing structures held good for the design of new structures, the rating stresses could be used for general design. The following extracts from the A.A.S.H.O. and the A.R.E.A. specifications relative to the rating of existing bridges indicate the conditions under which the rating stresses are to apply:

A.A.S.H.O. Specifications, Paragraphs 3.11.3 and 3.11.13. "The operating rating is the safe load-carrying capacity of the structure and is to be used in determining the maximum loads which may be permitted to pass over the structure. It is intended that structures requiring load limitations shall be kept in service only long enough to permit replacement or repair and that during such period frequent inspections are to be made."

"As a basis for the rating of existing structures, adequate information as to the dimensions and condition of the members in the structure shall be provided by competent field inspection. The data provided shall include detailed information as to the condition of the material showing reduced sections due to deterioration, accident, or other cause."

A.R.E.A. Specifications, Classification of Railway Bridges. "The classification of a bridge, as herein determined, is based on the heaviest moving load which may be operated over it in regular service for a limited time without subjecting it to such severe stresses, vibration, or

KLAMATH RIVER BRIDGE, CALIFORNIA, ILLUSTRATES SIMPLICITY OF DETAIL OBTAINABLE

wear of parts as seriously to impair its safety or serviceability."

A.R.E.A. Rules for Rating Existing Iron and Steel Bridges. Paragraphs 102, 103, and 104. "An inspection of the bridge shall be made to determine whether the actual sections and details conform to the drawings; any additions to the dead load not shown on the plan, such as heavier deck or rail, walks, pipe lines, conduits, signal devices, and wire supports; the position of the track with respect to the center line of the bridge; any loss of metal due to corrosion and wear; and the physical condition, noting any defects.

"The computation of stresses shall be made for the details as well as for the main members, giving particular attention to the increased load carried by any truss, girder, or floor member due to the eccentricity of the load, eccentricity of riveted joints and connections, unequal stress in tension members, and secondary stresses.

"Bridges shall be computed for the following loads and forces: dead load, live load, impact, centrifugal force, other lateral forces, and longitudinal force.

"If the stresses exceed those permissible under these rules, the speed shall be so restricted, if practicable, that the permissible stresses will not be exceeded. If the speed cannot be so restricted, or if the design or the physical condition of the bridge makes it necessary, it shall be strengthened or renewed. When the permissible stresses are closely approached, or when the physical condition of the main members or the details is not good, the bridge shall be kept under close inspection as long as it is continued in service."

CONTINUOUS INSPECTION REQUIRED

From an examination of the foregoing extracts it will be noted that these highly stressed bridges are to be operated under the following conditions:

1. The actual dead load is determined as accurately as possible.
2. The actual live load is known and controlled.
3. The actual sections of members are determined, allowance being made for reduction of area due to corrosion or other causes.
4. Additional stresses due to tracks being off center are computed, together with the effect of eccentricity of joints and connections.
5. The effect of lateral and longitudinal forces is included.
6. Bridges stressed to the limit are to "be kept under close inspection as long as they are continued in service" (A.R.E.A.), and are to "be kept in service only long enough to permit replacement or repair" (A.A.S.H.O.).

Since the foregoing conditions will not apply to bridges in general, it follows that the rating stresses should not be used for general design; and some of the conditions are not applicable in the case of emergency structures to be used for the duration only. To determine how much lower the design stresses should be than the rating stresses, Table I has been prepared. This table considers the following five cases:

1. Current bridge specification values of 18,000 lb per sq in. when lateral and longitudinal forces are omitted, and 22,500 lb per sq in. when such forces are included.
2. General design values, applicable to usual conditions.
3. Special design values, to be used only when design assumptions and computations are unusually accurate, dead-load and live-load assumptions liberal, and dead-load stresses re-checked after the details are complete.
4. Emergency structures for use for the duration only.
5. Rating capacity values. The values for rating capacity which have been adjusted to give approximately 80% for the condition of all forces acting simultaneously. No provision is needed for future addition of dead load,

TABLE I. RATIO OF WORKING STRESS TO YIELD POINT, IN PER CENT

(Structural Carbon Steel with Yield Point of 33,000 Lb per Sq In.)

	Current Specifications	General Design	Special Design	Emergency Structures	Rating Capacity
Provision for overrun in loads:					
Dead loads					
Original	5%	5%	2%	5%	2%
Future addition	5	5	5	0	0
Total	10	10	7	5	2
Live load	10	5	5	0	0
Average overrun in total loads	10	7	6	3	1
Loss of section	5	5	5	0	0
Approximations in stress analysis	8	8	5	8	5
Underrun in dimensions and physical properties, and non-uniform stress distribution	5	5	5	5	5
Margin for uncertainty and secondary stresses:					
Lateral and longitudinal forces omitted	38	25	20	25	..
All forces considered to act simultaneously	11	10	10	10	10
All above factors when lateral and longitudinal forces are omitted:					
Working stress, %	54.5	62.1	67.3	67.8	
Working stress, lb	18,000	20,400	22,200	22,400	
Recommended for use, lb	18,000	20,000	22,000	22,000	
All above factors when all forces are considered to act simultaneously:					
Working stress, %	68	70.6	73.5	77.1	81.2
Working stress, lb	22,400	23,300	24,300	25,400	26,800
Recommended for use, lb	22,500	24,000	25,300	25,300	26,400

for increase in live load, or for loss of section, and only a small allowance for overrun in dead load; and it is assumed that the design computations will be as accurate as practicable.

The values in other columns of the table have been made consistent with those set up for rating capacity, taking into account the differences in the governing conditions. The actual figures are, of course, arbitrary, being based mainly on judgment; but they are believed to be substantially correct.

Based upon a 33,000-lb per sq in. yield point, current bridge specification values of 18,000 and 22,500 lb per sq in. provide nominal safety factors of 1.83 and 1.46, respectively. These factors are sufficient to provide for a 5% margin in the computed dead load, a 5% increase in dead load to cover future paving or other addition, a 10% increase in live loads, a 5% loss in section, 8% for approximations in stress analysis, and 5% for underrun in dimensions and physical properties, and non-uniformity of stress distribution. With these margins provided, there still remains a margin for uncertainty—a true safety factor—of 1.38 when lateral and longitudinal forces are omitted, and 1.11 when all forces are considered to act simultaneously.

TIED ARCH OF UNIQUE TYPE—ST. GEORGE'S BRIDGE, DELAWARE
Use of Bottom Chord as Stiffening Member Gave Economical Solution

From an examination of these margins, several conclusions are drawn:

1. The allowance for a 5% overrun in the computed dead loads is believed to be about correct for average designs.

2. The allowance for a 10% overrun in live load is somewhat greater than necessary, if live loads are chosen properly.

3. The allowances of 5% for future increase in dead load, 5% for loss of section, 8% for approximations in stress analysis, and 5% for underrun in dimensions and physical properties and non-uniformity of stress distribution, are reasonable.

4. The margin for uncertainty of 38% when lateral and longitudinal forces are omitted seems unnecessarily large, while the margin of 11% when all forces are considered is about right.

The margin of uncertainty when lateral and longitudinal forces are omitted, while it need not be 38%, must be considerable, not only because maximum live load alone will produce this condition of stress, but also because a certain amount of stress—frequently difficult to compute—from lateral and longitudinal forces will nearly always be present. The margin when all forces are considered, on the other hand, can properly be quite small, because the simultaneous occurrence of maximum live load and lateral and longitudinal forces, together with the other unfavorable assumptions (loss of section, and so forth), is so improbable that it will occur rarely, if at all.

Considering now the values that should be adopted for general design, the preceding discussion has indicated that the margins provided by the present specification unit stresses are satisfactory with the exception of the 10% allowance for overrun in live load and the 38% margin for uncertainty when lateral and longitudinal forces are omitted. Reducing these figures to 5% and 25%, respectively, appears to be reasonable. Substituting these values, the resulting unit stresses for structural carbon steel become approximately 20,000 lb per sq in. when lateral and longitudinal forces are omitted, and 24,000 lb per sq in. when all forces are included.

UNUSUALLY ACCURATE DESIGN

Considering next the case of special design, to apply only when design assumptions and computations are unusually accurate and the dead-load and live-load assumptions liberal, with the dead-load stresses re-checked after the details are complete, it is evident that reductions may properly be made in the allowances for overrun in dead load, approximations in stress analysis, and margin for uncertainty when lateral and longitudinal forces are omitted. Making these changes, the unit stresses for the special design of bridges become 22,000 lb per sq in. when lateral and longitudinal forces are omitted, and 25,300 lb per sq in. with all forces acting.

In the case of emergency structures, the accuracy of design will be similar to that assumed for general design rather than for special design, since plans will usually be prepared under pressure of time that will not permit of refinement and rechecking. The margins provided in the case of general design will therefore apply, except that no provision need be made for future increase in dead load, for overrun in live load, or for loss of section. These values lead to the same unit stresses and safety factors as were found for the case of special design.

Unit stresses for compression, shear, and bearing should, logically, be made proportional to the basic tensile unit stresses, and it is recommended that this procedure be followed, except possibly in the case of axial compression. Our knowledge of columns is still far from complete; and since the yield point of the material approximates the ultimate strength of a column, a small safety factor with respect to the yield point is undesirable. It therefore appears desirable to make less increase in the allowable unit stresses for the design of columns than in the basic unit tensile stresses.

PROBLEMS OF FATIGUE

Bridge specifications have usually been based on the assumption that fatigue effects can be neglected except in the case of members subject to reversal of stress during the passage of the live load, which members are to be proportioned for the maximum stress of one kind plus one-half of the smaller stress. This procedure has been on the safe side for members subject to a moderate number of reversals and on the side of danger for those having a

CONTINUOUS GIRDER SPANS OF THE THOMAS A. EDISON BRIDGE OVER RARITAN RIVER, N.J.

large number; but the conservative safety factors used have been large enough to cover such fatigue effects in the case of structural carbon steel. With the use of higher unit stresses and the necessity of avoiding any waste of steel, however, it becomes essential to examine this question carefully.

Fatigue problems can most readily be studied by means of a diagram similar to Fig. 1, which gives approximate fatigue strengths for riveted joints of carbon steel for 50,000, 100,000, 1,000,000, and 2,000,000 cycles of stress. From this diagram it will be noted that the specification procedure described in the preceding paragraph is correct for 100,000 cycles of stress. For approximately 35,000 cycles, the fatigue strength under full reversal is 33,000 lb per sq in.; hence no provision for reversal is required when the number of cycles is less than 35,000.

The diagram also shows working stresses for various numbers of stress cycles, on the assumption that the basic unit tensile stress is 20,000 lb per sq. in. For any other basic unit stress, all values would be in proportion; for instance, if the basic stress were made 22,000 lb per sq in., all lines would be raised 10%.

One hundred thousand cycles of stress, representing approximately 6 cycles per day for 50 years, or 9 per day for 30 years, is a reasonable value for the average member in a railway or highway bridge, so that the specification provision for reversal is in general adequate without being wasteful. It should be noted that we are interested only in loadings that produce nearly maximum stress, since a large number of repetitions of stress materially smaller than the maximum has no appreciable effect on the fatigue strength.

There are certain members that may be subjected to many more than 100,000 cycles of maximum stress during the lifetime of a bridge. Railway stringers and other members of railway bridges which receive their maximum stresses from the passage of a single heavy engine and tender come within this classification, as do also highway stringers loaded by a single heavy truck. The number of repetitions for such members may well be 1,000,000 to 2,000,000. Where the simultaneous loading of two railway tracks is required, or the simultaneous passage of two heavy trucks, the number of repetitions will be much smaller, generally less than 100,000.

For members subjected to many cycles of stress, the working stresses can be taken from the values for 1,000,000 or 2,000,000 cycles. It would also be satisfactory to use for such members the 18,000-lb per sq in. basic stress of the A.R.E.A. and A.A.S.H.O. bridge specifications, as that is the basis on which they have been designed in the past, and such designs have proved satisfactory.

It has been noted previously that the fatigue strength equals the yield point for approximately 35,000 cycles of stress. This condition represents 2 cycles per day for 50 years, or 3 per day for 30 years. Since trusses of long-span highway bridges will not be loaded to a maximum as frequently as this, it is not necessary to design them for the effect of reversal. This statement applies particularly to chords of continuous trusses and of anchor spans of cantilever bridges. It may also apply to web members of highway trusses; but since such members, when subject to reversal, are usually light, it is preferable to design them for the effect of reversal. It has been the usual practice to neglect the effect of reversal when wind stresses are included. This procedure is correct, since maximum stresses of this kind will occur but rarely.

ALLOY STEELS

Alloy steels are practically unobtainable for bridge construction at the present time, hence the question of design stresses in such steels is not important. Theoretically the safety factor between the basic unit tensile stress and the yield point should be the same for alloy steels as for carbon steel. However, we do not have the

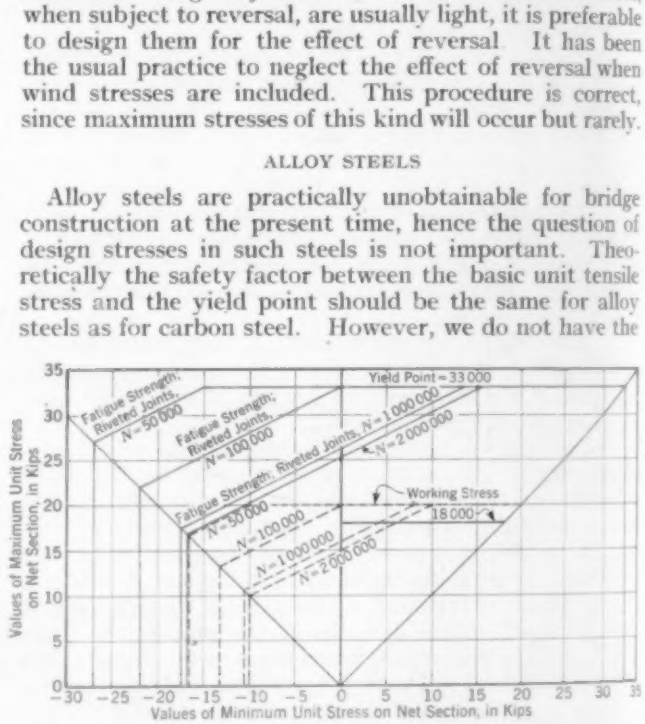


FIG. 1. FATIGUE STRENGTHS OF RIVETED CARBON STEEL

background of experience with overstressed alloy steel bridges that we have for carbon steel bridges; hence it is necessary to be somewhat conservative.

Fatigue stresses will require careful study if unit stresses in alloy steels are to be raised materially. The fatigue strength under 1,000,000 to 2,000,000 cycles of reverse stress is not much higher for alloy steel than for carbon steel, and even for 100,000 cycles the difference is not large. For some small number of cycles—say 10,000 to 20,000—the effect of reversal in alloy steels can be neglected.

Los Angeles' Street Traffic Problem

Curb Parking of Motor Vehicles Has Restricted Arteries of This Metropolitan Area

By E. E. EAST, Assoc. M. Am. Soc. C.E.

Chief Engineer, Automobile Club of Southern California, Los Angeles, Calif.

ONE and one quarter million motor cars in their daily rush from here to there strain to bursting the capacity of Los Angeles streets. A stagnant growth of parked and parking cars makes free movement increasingly difficult. Mr. East has had the opportunity to observe this ever-growing use of automobiles and trucks and has here analyzed its causes and effects. Provision of parking areas off the street so that traffic can use the total width would, in his opinion, readjust the balance between capacity of roadway and volume of traffic flow.

IN major part the popularity of the motor vehicle and its widespread use is due to the fact that it provides at any time complete transportation for the individual between where he is and where he wants to go. Parking is an essential and inseparable part of this form of transportation. The importance of parking facilities becomes apparent even to the casual observer when the lack of such facilities clogs lines of transit and delays delivery of goods and passengers. Although the present war emergency may temporarily alleviate the situation, it is one that must eventually be faced.

There has been no essential change in the city plan since the beginning of community life, and although urbanism has had its greatest growth since the advent of the automobile, and because of the automobile, this growth has conformed and is still conforming in every essential detail to the plan of the original city. This plan does not include either transit or terminal facilities for the motor vehicle, which is today providing more than 90% of all urban transportation. For this reason, the motor vehicle has become the problem child of the American city.

According to data secured by the Automobile Club of Southern California, in 1941 there were about one and one-quarter million motor vehicles in the Los Angeles area. The average daily use totaled about twenty-five million vehicle-miles. A maximum hourly use of about 7.3% of the 24-hour total occurred between 5:00 and 6:00 p.m., while a minimum of about 0.43% occurred between 3:00 and 4:00 a.m. The maximum number of vehicles in motion at any instant was about 10% of the total. At the time of maximum use, parking area was required for the remaining 90%, or 1,125,000 vehicles. Allowing 200 sq ft for self-parking, the area required, indoor and outdoor, was about 5,160 acres, or 8 sq miles.

PARKING A MAJOR PROBLEM

Obviously, the parking problem of the Los Angeles area arises from a high concentration of parked vehicles in small areas. There are more than one hundred focal points in the area where parking has become a major problem. Before the war emergency the number was increasing rapidly and the intensity of the problem within areas of high concentration was becoming more serious with the growth in motor vehicle registration and use.

The population of the Los Angeles area increased from about 936,000 in 1920 to 2,785,000 in 1940. During this period the number of motor vehicles increased from about 187,000 to more than 1,160,000. The daily use increased from about 3,000,000 miles in 1920 to nearly 25,000,000 in 1940. These figures justify the statement that the Los Angeles area grew up with the automobile and has been a testing ground for motor-vehicle transportation in large urban centers.

Decentralization has come to be a much used word in recent years. It is usually associated with the migration of urban people and enterprises away from the center of the city toward and beyond its limits, a movement generally credited to the motor vehicle. The spread of population away from the center has characterized the growth of cities during all time. Congested living quarters is a condition of necessity rather than choice. The rate and direction of spread has been and is influenced by many factors, chief among which is transportation.

The outward growth of cities is clearly shown in the population growth of the Los Angeles area. At the beginning of 1910 the City of Los Angeles had an area of 85 sq miles and a population of about 313,000. The remaining portion of the metropolitan area had a population of 191,000. In 1920 the area included in the city of 1910 had a population of 569,000, and the remainder of the district a population of 368,000. By 1930 the figures had increased to 578,000, and 1,730,000, and for 1940 they were 620,000 and 2,160,000, respectively. During the three decades the population of the 1910 area increased 307,000, while the outside area, much of it included by annexation in the 451 sq miles of city, increased to 1,969,000.

A most significant effect of motor-vehicle transportation on urban and suburban growth is the development of communities of low population density. This is directly opposed to mass transportation, which develops communities of high population density.

From Table I, showing population densities, it will be noted that New York, Chicago, Boston, and Philadelphia rank high. These cities had extensive mass transportation facilities in operation years before the auto-

A Residential Street, Showing Typical All-Day Parking

mobile became a factor to be reckoned with in urban transportation.

Growth of population away from old city centers is a desirable trend. Decentralization of retail business and industry is an urban trend set in motion by motor-

TABLE I. POPULATION DENSITY PER SQUARE MILE IN 1940 OF CITIES HAVING 500,000 OR MORE INHABITANTS

		Population 1940	
City	Area	Total	Density
Baltimore	78.7	859,000	10,915
Boston	43.9	771,000	17,563
Buffalo	39.4	576,000	14,619
Chicago	206.7	3,397,000	16,434
Cleveland	73.1	878,000	12,011
Detroit	137.9	1,623,000	11,769
Los Angeles	451.0	1,504,000	3,335
Los Angeles*	85.2	620,000	7,277
L. A. Met. Dist.	1,235.0	2,780,000	2,251
Milwaukee	43.4	587,000	13,525
New York	299.0	7,455,000	24,933
Philadelphia	127.2	1,931,000	15,181
Pittsburgh	52.1	672,000	12,898
St. Louis	61.0	816,000	13,377
San Francisco	44.6	635,000	14,238
Washington	61.4	663,000	10,798

* Including only area as of January 1, 1910.

vehicle tranportation and threatens the stability of both the future American city and this form of transportation. While it is evident that motor-vehicle transportation and densely populated business districts are incompatible, it is equally evident that a substantial part of business decentralization has been premature, and consequently has resulted in vast economic loss. This premature movement can be traced directly to the complete failure of the city to provide adequate facilities for the operation and storage of motor vehicles.

Business is encouraged to move out to the people. New areas of congestion are created, clogging the line of transit and thus giving increased momentum to the decentralization of established business centers. There can be no security of land investments or improvements when the problems that encouraged decentralization of

"FREE PARKING FOR CUSTOMERS" HAS BEEN FOUND TO BE PRODUCTIVE ADVERTISING

old centers are being reproduced in the new centers. The efficiency of the motor vehicle is thus being destroyed.

The survey of the parking problem in the Los Angeles area, concluded in 1941 by the Engineering Department of the Automobile Club of Southern California, has developed no new information. On the other hand, it has verified the information obtained through previous studies, justified former recommendations, and emphasized the alarming rate at which the problem is growing. The study has been confined in major part to a study of trends and to the effect of these trends upon the growth of the metropolitan area and motor-vehicle transportation. Such items as parking violations, curb storage capacity, parking meters, flow in and out, parking turnover, number and capacity of off-street parking facilities, parking charges, and many others, which relate to surface treatment for an internal disease, are of little value in the solution of a fundamental problem, and have received little or no attention in this study.

DISCUSSION OF SOME POINTS OFTEN RAISED

Some currently expressed views which tend to confuse the issue have been analyzed. The following are typical:

1. Decentralization of the central business district is reducing the assessed valuation, which results in a loss to the city in taxes.

The survey shows that decentralization of the central business district, as well as that of other long-established business districts throughout the metropolitan area, results in a personal loss rather than a public loss, for the outward movement of business has, up to the present time, been confined in major part within the corporate limits and the rise in valuation beyond the old centers compensates for the loss within. The 1941 assessed valuation of land and improvements in the central district is about 7% of the county total. A valuation curve extending in an east-west direction across the metropolitan area clearly shows the wide spread of growing values in the metropolitan area.

2. There is adequate off-street parking space in the central business district. The word "adequate" is relative and most frequently used in connection with a point of view; it is therefore subject to a broad interpretation. Our study shows that there may be sufficient off-street parking facilities when considering the district as a whole, but space is wholly inadequate in all those trading centers where most needed. The woman shopper is only mildly impressed, if at all, over the fact that there is parking space in the vicinity of the civic center if she desires to shop along Seventh Street, seven blocks away.

3. A business center must be closely built up to attract business.

This is a tradition handed down from the days of mass rail transportation. It ignores the fact that an almost countless number of establishments are today doing a thriving business in locations far removed from closely built-up business centers. Such establishments include hotels and restaurants where reservations must be made in advance, department stores, beauty parlors, professional buildings, novelty shops of every description, and markets. In fact, every class of business enterprise is found widely scattered throughout the metropolitan area. Our study fully justifies the statement that business has gone out to the people since the people will not or cannot any longer go to it.

4. Every city must have one large central business district.

Our study leads us to ask why. We find in the metropolitan area of Los Angeles more than a hundred trading centers where every commodity and service essential to daily life may be obtained. We find, also, considerable evidence that mass rail transportation stimulated the growth of the central business district and is largely responsible for its existence today.

The number of persons entering the central business district during a 12-hour day decreased from about

700,000 in 1923 to some 550,000 in 1938. While the number entering by private automobile has increased steadily since 1923, the number entering by public transportation facilities has decreased steadily. In 1924 there was off-street capacity in the district for parking 10,335 automobiles. In 1929 the capacity had increased to 36,521, in 1937 to 43,151, and in 1941 to 46,166. The central business district here referred to is bounded by Figueroa Street, Sunset Boulevard, San Pedro Street, and Olympic Boulevard.

PARKING AREA REQUIRED FOR AN INDUSTRIAL PLANT USUALLY EXCEEDS ITS TOTAL FLOOR AREA

Between 1920 and 1940 some 1,850,000 new inhabitants came into the Los Angeles area, and during this period a substantially large number of business buildings in the downtown district were demolished. While it may be assumed that the total of retail sales in the central business district has decreased, it seems reasonable to assume that the volume of sales per individual establishment may have increased. Further, the prediction appears to be reasonable that the volume of sales per individual establishment will continue to increase as the number of establishments decrease up to a point where a proper relation between transit and terminal facilities has been established.

A study of the problems of motor-vehicle transportation in a growing urban community would be incomplete and of little value if it considered only those areas of stationary or declining activity. It must include all parts of the community and observe the effect of growing areas upon the transportation problem of the area as a whole.

The growth of outlying business centers has invariably followed, and continues to follow, a common pattern. Beginning at every intersection of major streets the expansion is in the direction of traffic. The early plan of these new centers resembled a cross or a plus sign. As growth continues, the arms of the numerous crosses on the gridiron of major streets meet and thus every major street and highway in the Los Angeles area has become or will soon become closely built up with every class of business establishment. These establishments depend in large part upon the motor vehicle for support. But where are these vehicles to be parked?

THE PROBLEM ALONG WILSHIRE BOULEVARD

Wilshire Boulevard is a typical example of business development along a major traffic street and affords an accurate answer to the question of parking. At any time during the day along this boulevard between Figueroa Street and Santa Monica Boulevard, and in the adjacent territory bounded on the north by Third Street and on the south by Olympic Boulevard, there will be found 19,600 automobiles parked at the curb, 4,170 on lots, and 641 in garages. As the major part of the area adjacent to Wilshire Boulevard is residential, this all-day parking is a matter of grave concern to property owners, who see a blight slowly but surely creeping over the area and the value of their holdings depreciating.

Curb parking narrows a street by two lanes and impairs the use of two additional lanes. With more than 250,000 motor vehicles crossing Wilshire Boulevard every day in a north-south direction between the east and west limits of this area, it is quite apparent that the uncontrolled growth of new business areas is slowly but surely choking the streets and highways and destroying the efficiency of the motor vehicle. Furthermore, these new business areas are reproducing with dogged determination the identical conditions which caused the decline in the old business areas. Conditions in the Wilshire district are identical with those along and adjacent to every major thoroughfare in the Los Angeles area.

In the course of our study we interviewed many business and professional men who left the central business district to escape congestion and afford their patrons ease of access and convenient parking. The majority are inclined to view the move in the light of an experiment, for they frankly admit that the problems from which they tried to escape are already overtaking them in their new locations.

Motor vehicle registrations in Los Angeles County increased 37.7% between 1930 and 1940, and population increased 26.1%. The number of persons per registered vehicle in 1930 was 2.62, and in 1940, 2.40. These figures show that the ownership of vehicles is increasing with population. The diminishing number of persons per registered vehicle, coupled with the fact that the annual consumption of gasoline per vehicle in California is substantially below the average for the United States, indicates a factor other than population affecting the rapid growth of registration. This, we believe, to be the growth in multiple-car families.

An increase in the average annual consumption of gasoline per vehicle from 592 gallons in 1930 to 626 gallons in 1940 indicates a growing dependence upon motor-vehicle transportation. A rapid increase in the population of the Los Angeles area during the present decade can be predicted with certainty. It is estimated that since the last census there has been a gain of almost a quarter of a million people. Likewise, motor vehicle registration and use have increased and will increase at an even faster rate than population.

The parking survey of the Los Angeles metropolitan area emphasizes the intimate relation between existing

SUGGESTED DEVELOPMENT OF A RETAIL SHOPPING DISTRICT ALONG A MAIN TRAFFIC ARTERY

Character of Development Would Permit Interior Parking Plazas

conditions of transit and storage and deterioration of both business and residential districts. It also points clearly to the growing seriousness of the problems of motor-vehicle transportation and the urgent need for the adoption and development of a comprehensive plan. The following recommendations are presented with the view of hastening the readjustment of the Los Angeles area to motor-vehicle transportation:

1. A sufficient area in business and industrial districts should be cleared to provide adequate off-street parking. It is fortunate that at this stage in the growth of the Los Angeles area there remains in all industrial and business districts ample area of unused land, or land occupied by obsolete buildings of little value, adjacent to or in close proximity to highly developed property, which can readily be converted into parking lots. The cost of such acquisition will be small compared to the ultimate loss to these districts if parking facilities are not provided. Two acts were adopted at the last session of the California Legislature which authorize the formation of parking districts and the acquisition and operation of parking lots or other parking facilities. It is of the utmost importance that the entire business area in any community be included in the parking district to prevent strangulation from surrounding uncontrolled parking.

RECOMMENDATIONS FOR PARKING LOTS

Off-street parking lots should be so distributed that they will provide convenient access to business establishments, office buildings, and recreational enterprises. As noted in the general discussion of the parking problem, the popularity of the automobile is, in large measure, due to the fact that it provides complete transportation from point of origin to destination. Other conditions being equal, the customer will favor those establishments that afford convenient parking.

All parking lots should be planned to permit free movement by individual vehicles and self-parking. Two classes of parking lots should be provided, one for vehicles parking over three hours, and another for vehicles parking three hours, or less. Parking fees might be charged in long-time parking lots, while free parking in three-hour lots would encourage their use.

The average owner prefers to park his automobile himself and leave it locked. He resents the rough usage it frequently receives at the hands of attendants and dislikes having it backed into and shifted about in parking lots. Free self-parking for customers and for short business and professional calls has become the general practice in new districts. Long-time or all-day parkers will not object to a moderate fee for convenient parking.

Parking lots should be landscaped or otherwise designed to present a pleasing appearance. People appreciate agreeable surroundings, as evidenced by the lawns, flowers, and shrubs which they maintain around their own homes. The removal of obsolete and unsightly buildings, poles, and advertising signs, and the proper landscaping of parking lots will give a more pleasing appearance to business and industrial centers and pay large dividends through increased patronage.

2. All loading and unloading of merchandise in commercial districts should be done in parking lots or alleys at the rear of buildings. The loading and unloading of merchandise at the curb interferes both with the movement of vehicles in the street and with the movement of pedestrians on the sidewalk. Off-street parking lots conveniently located will provide access to the rear of buildings where merchandise can be loaded and unloaded, and thus relieve streets and sidewalks of congestion from this source.

3. Parking on all residential streets should be limited. All-day curb parking in front of residential property in the vicinity of trading centers depreciates the value of such property and interferes with the movement of vehicles into and out of these centers. This practice is prevalent in every trading center in the Los Angeles area and is rapidly creating a blighted fringe surrounding and choking these centers.

4. Curb parking should be completely prohibited on all commercial streets when adequate provision has been made for off-street parking. Curb parking reduces the width of a street by two lanes and impairs the use of two additional lanes. The more frequent the turnover the greater the impairment. Physical widening of a street is a costly and ineffective attempt to overcome the evil of curb parking. Effective widening can be accomplished at a fraction of the cost by complete prohibition of curb parking. A no-parking ordinance which permits certain classes of vehicles to park at the curb defeats its purpose, for one parked vehicle impairs the efficiency of the street for moving traffic in about the same degree as a full row of parked vehicles.

5. Provision should be made for off-street parking areas in all new subdivisions and in connection with new buildings both public and private, new trading centers, apartment houses, and theaters. Obviously, to attempt to cure an evil in one community and permit the same evil to develop in other communities would be futile.

6. All street rail lines should be removed and all buses so routed as to provide convenient service to all parts of business and industrial areas. While the ultimate substitution of motor coaches for street railway cars in city service is reasonably certain, the process is slow and not keeping pace with the ever-growing need for street space and a flexible, expansible mass transportation service. The delay in replacing the obsolete and limited street service with modern metropolitan motor-coach service is costly and invites the establishment of uncoordinated services which will, by their very nature, fall far short of meeting the transportation needs of the Los Angeles metropolitan area.

With these provisions for terminal facilities, the congestion that halts the economical and rapid transportation of passengers and merchandise could be eliminated. Resulting stabilization of property values and savings in transportation costs would justify the cost of this adjustment to motor vehicle transportation.

Integral Centering for Concrete Arch Ribs

Unusual Construction Procedure Expedites Building of Asphalt Plant for Borough of Manhattan, New York

By GILBERT M. SERBER, M. AM. SOC. C.E.
PRESIDENT, STOCK CONSTRUCTION CORPORATION, NEW YORK, N.Y.

MODEL STUDY OF MANHATTAN MUNICIPAL ASPHALT PLANT

THE new municipal asphalt plant for the Borough of Manhattan is a good example of modern functional design, as the intended use of the structures was the chief factor determining their shapes. The project, which has anything but the appearance of an industrial plant, presented unusual construction problems. This article will deal solely with the construction of the mixing plant building, the principal structure of the group, and the most unusual of all from the point of view of appearance and construction methods required.

In order to visualize the combination of shapes involved, the City constructed a model of the plant before taking bids for its construction. (This model appears in one of the accompanying photographs.) The arched structure houses all the mixing equipment and is accordingly known as the Mixing Plant Building. Its outline is that of a true semi-ellipse and it is composed of four identical reinforced concrete ribs spaced 22 ft on centers. Each rib has a rise of 84 ft 6 in. to the intrados and a clear span of 90 ft. The spaces between ribs are enclosed by thin reinforced concrete arch barrels 8 in. thick, and the two ends of the building are closed by curtain walls likewise 8 in. thick. These last are reinforced at the inside faces by cross beams and pilasters, monolithic with the wall, which serve as "strong-backs" transferring the wind load stresses to the arch ribs.

The end walls are retained at the rib in a continuous key formed in the intrados, permitting the rib to deform without placing load on the end wall. The intermediate barrel walls are doweled continuously to the ribs at each side. They rest against continuous projecting lips which form part of the arch ribs at the intrados and fit into keys cast in the sides of the ribs.

While all the curves in the structure are true semi-ellipses, none of them are parallel, and in order to detail and construct the forms, centering, and keys, it was necessary to develop the equation of each individual curve and to compute the dimensions necessary for construction purposes. The equations are as follows:

Rib extrados	$2.920X^2 + Y^2 = 7{,}744.000$
Outer face of barrels .	$3.165X^2 + Y^2 = 7{,}140.250$
Rib intrados	$3.402X^2 + Y^2 = 6{,}889.000$

Rib sections vary in depth from 6 ft 6 in. at the springing line to 5 ft at the crown, and are uniformly 2 ft 4 in. wide at the extrados and 3 ft wide at the intrados (Fig. 1). The 3-ft width extends from the intrados to the inside face of the barrels, at which point the 2-ft 4-in. width commences, thereby forming a shelf 4 in. wide at each side of the rib to support the barrel walls. After computing the various dimensions and offsets required, the arch curves were plotted on the surface of one of the adjacent streets to a scale of 3 in. = 1 ft, and used as a means of checking all the computed distances by direct measurements. This procedure enabled the form builders to visualize the relationships of the various curves and reduced chances for error.

DIFFICULT foundation conditions draw forth the skill and imagination that characterize modern engineering enterprises. In the case of the structure here described, its location on a heterogeneous land fill presented a problem of centering and forming for the arches. This was solved by the substitution of structural steel arches for conventional reinforcing bars. Mr. Serber here describes a method that permitted a rapid construction schedule and also effected savings in materials and erection time.

CENTERING DETERMINED CONSTRUCTION PLAN

Before a construction plan could be formulated, it was necessary to determine the general type of centering to be constructed and the general system of form work to be used. First consideration was given to the centering.

Rib reinforcement as originally planned consisted of double layers of 1-in. square bars spaced 4 in. center to center at both intrados and extrados, together with double stirrups spaced 18 in. on centers, and also longitudinal temperature reinforcement in the faces of the ribs. In all, each rib included about 125 cu yd of concrete and 10 tons of reinforcing steel, a total weight for each rib of about 525 kips. Each intermediate barrel included about 100 cu yd of concrete and about 10 tons of reinforcement, a total weight for each barrel section of about 425 kips. The total weight of arch ribs and barrels was therefore about 3,375 kips, and this load had to be supported until the concrete could develop sufficient strength.

To erect a conventional system of timber posting and bracing to the required height—about 90 ft above the existing ground surface—promised to be a slow and expensive procedure. This was particularly true considering that centering would have to be provided for the entire structure, since the time limit of the contract did not permit of re-usage. Furthermore, such centering would completely fill the interior of the building, precluding the possibility of installing any of the mechanical equipment and other interior work until all the arches were completed, the concrete had attained sufficient strength, and the centering had been removed. All this would represent a delay of at least two months and possibly more. The objections to this type of centering were multiplied when consideration was given to means of supporting it.

FOUNDATION PRECLUDED CONVENTIONAL BRACING

The building site was filled ground, which had formed part of the East River until recent years. About thirty years ago a masonry sea wall supported on a pile platform was constructed through the area. It extended diagonally from what is now the southeast corner of the Mixing Plant Building to the northwest corner, the top of the wall being about 5 ft below the floor of the building. At the same time riprap fill was deposited in large quantities and settled down in the soft mud and silt which formed the original river bottom. Core borings disclosed that ledge rock could be reached at depths of from 25 to 55 ft below the surface, and that the overlying

Forms in Place for Second Rib Sections

material consisted of river mud, silt, miscellaneous fill, timber cribbing, and riprap.

Because of this it was apparent that centering for the arch forms could not be carried directly on the ground but would have to be supported on piles driven to rock. The permanent foundations of the buildings were to be similarly supported and the selection of the type of pile to be used constituted a problem in itself owing to the difficult nature of the material penetrated. In addition construction of a temporary pile foundation to support the arch centering promised to be slow and costly. Hence it was concluded that successful performance of the construction would depend upon developing a system of centering which would be supported on the permanent foundations of the building, and would occupy a minimum amount of space within the structure.

After studying various systems of steel trusses resting on the foundations of the arch ribs, and discarding them because of the large quantity of steel required, the idea of utilizing the rib reinforcing steel was conceived. A practical plan was developed whereby the centering became an integral part of the arch ribs, replacing the reinforcing bars as originally designed. Briefly, the scheme selected consisted of structural steel arches, the chord members consisting of angles back-to-back, held together by latticing, and the arch faces made up of diagonal angles forming a sort of Warren truss. Details of the design, showing sizes of members and general dimensions, are given in Fig. 1.

TIES PREVENTED DEFLECTION DURING CONCRETING

The question of deflection under the weight of the wet concrete was next investigated. After much consideration and consultation with the engineers of the Borough of Manhattan, the sequence of concrete placing was determined. The critical condition in so far as deflection was concerned obtained during the placing of the crown section. Computations indicated that a maximum deflection of about 1 in. could be expected, which might produce unsightly surface cracks in the concrete encasement.

In order to avoid any possibility of such an occurrence, ties across each arch were installed at El. 75. They consisted of double cables tied to each leg of the arch and provided with turnbuckles for adjustment. During placing of the concrete, a piano wire heavily weighted was suspended from the crown; a scale was secured to the wire about 5 ft above the ground; and continuous level readings were taken.

The first reading was taken at 8:00 a.m., the air temperature being 62 F. During the early afternoon, with half the crown piece completed, the temperature had risen to 87 F, and the level readings indicated a rise of about 1 in. instead of any deflection at all. This upward movement, while at first rather startling, was adequately explained by elongation of the steel due to the rise in temperature. Final readings, taken the following morning, indicated a net deflection of the truss of about 1/8 in. This marked deviation from the theoretical deflection of 1 in. was probably due to the great rigidity of the structure as fabricated.

TRUSSED REINFORCING EFFECTED SUBSTANTIAL SAVING

As finally designed, the steel arches weighed approximately 15 tons each, against which could be credited 10 tons of reinforcing steel saved. Thus the net cost of the centering was represented by the difference in cost between fabrication and erection of 60 tons of structural steel, less the cost of furnishing and installing 40 tons of reinforcing steel. The result showed a very decided saving over the estimated cost of timber centering, and at the same time left the interior of the building entirely clear and unobstructed, with the exception of such temporary scaffolding as was needed to facilitate placing and stripping of forms for the upper 20 ft of the arches.

Fabricating the steel arches presented a problem which was solved when the Jones and Laughlin Steel Service, Inc., undertook to perform the work. At their Long Island City shop adequate floor space was available for bending the cord angles and assembling the trusses. A full-sized templet was prepared and the cord angles were

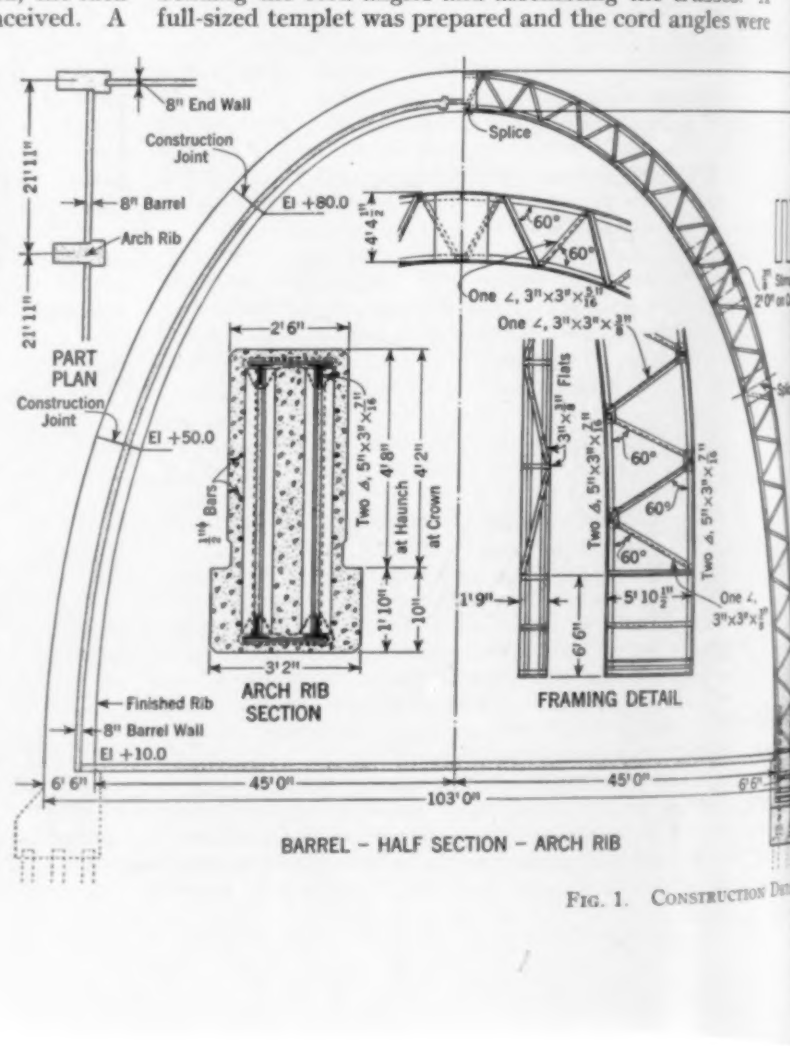


Fig. 1. Construction Det…

bent in 60-ft lengths. Three splices were included in each truss, one at the crown and one in each leg. Temporary light steel longitudinal bracing between arches was provided to tie them together during erection and concreting operations, thus eliminating sway and reducing vibration.

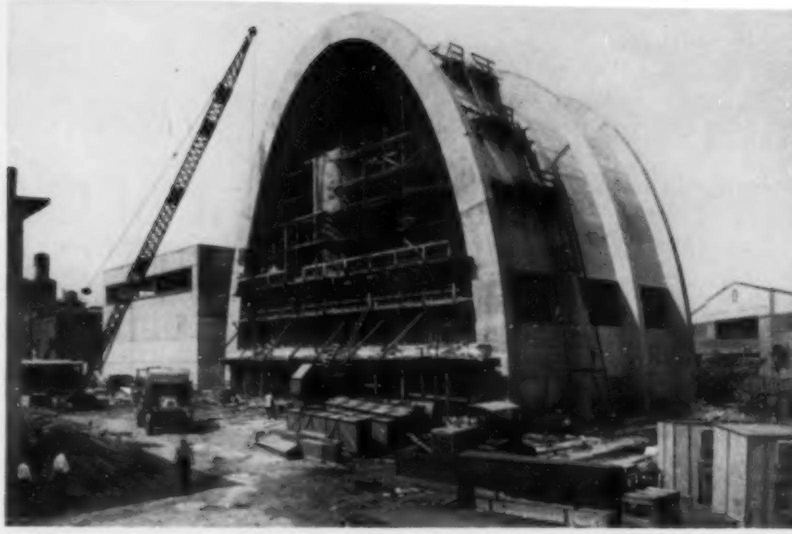
The erection procedure was simple—the crown splice was assembled on the ground and riveted; then the legs were erected and guyed. Finally the crown piece was set down on them and the two leg splices were riveted in place.

Architectural Effect Enhanced by Forming

Design and installation of concrete forms were of course simplified and facilitated by reason of the integral centering which had been designed to carry the entire weight of the concrete. However, in order to reduce deflection to a minimum, it was decided to advance construction of the ribs very substantially ahead of the barrel walls. The first rib sections were placed in monoliths up to El. 50. Form construction consisted of $^{3}/_{4}$-in. plywood facing. Joints in the plywood panels were cut to radial lines for the sake of appearance. Wales consisting of pairs of 2 by 6-in. planks spaced on 18-in. centers at intrados and extrados, and 2 by 10-in. planks spaced on 18-in. centers at the sides were held together with lag screws and ties, so placed that no tie passed through any exposed surface, thereby eliminating any unsightly patching of bolt holes.

These wales were held in proper alinement and adjustment by means of vertical pairs of 2 by 6-in. planks as indicated in Fig. 1. The entire system of rib forms was tied to the steel arch at the intrados by means of $^{3}/_{4}$-in. U-bolts passing around the lower cord angles. When the rib concrete had been placed to El. +50, the barrel walls were constructed in 8-ft lifts up to El. 27, thereby tying the four arches together laterally before advancing the rib construction to full height.

The second construction joint in the ribs was located at El. 80, and rib concrete was placed to this elevation, after which barrel concrete was placed to El. 50+. Up to this point all the concrete had been placed by

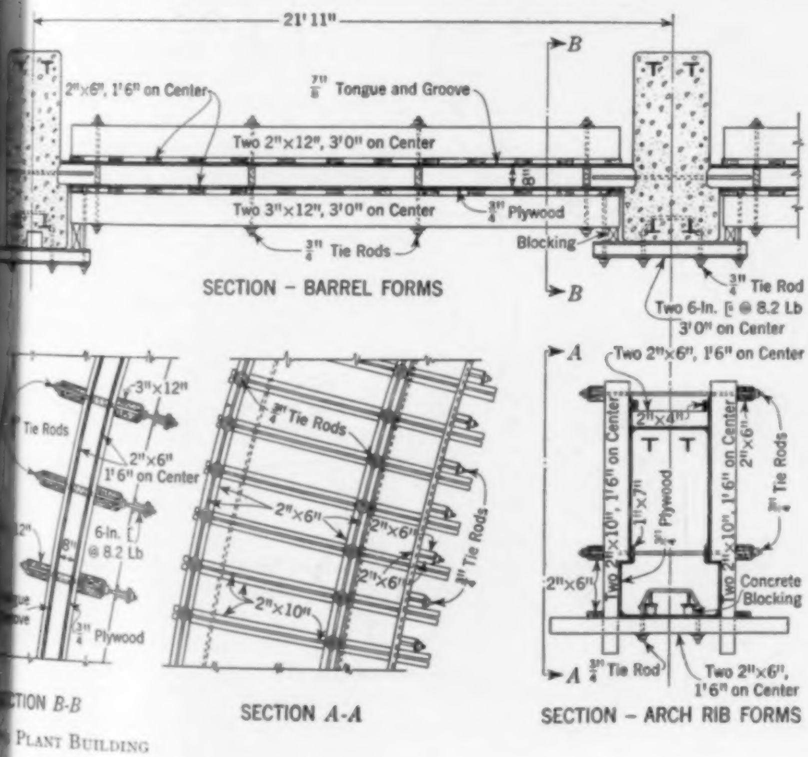


Structure Nearing Completion, Showing End Wall Forms and Reinforcement

crane and bucket exclusively, using boom lengths of 100 ft and light-weight, 1-cu yd buckets.

Before placing the crown sections of the ribs, a scaffold was suspended at El. 75 for the entire length and breadth of the structure in order to facilitate construction and stripping of forms at the top of the arches. The closing pours of the ribs were then made. Since the crown was about 90 ft above the surrounding ground elevation, the tops of the crown pieces had to be placed partly by wheelbarrow from a central hopper located over one of the end ribs.

The barrel wall forms were supported by the same U-bolts which had been used to carry the rib forms. The details of the plan consisted in bolting pairs of 6-in. channels or angles to the intrados of the concrete ribs by means of the U-bolts and supporting thereon pairs of 3 by 12-in. wales, spaced 3 ft center to center, tied to pairs of 2 by 12-in. wales at the exterior face of the barrel wall by means of $^{3}/_{4}$-in. tie rods. The combination of interior and exterior wales was adequate to span the distance of approximately 20 ft between ribs without any additional support.



Lagging on the inside face of the barrels consisted of $^{3}/_{4}$-in. plywood supported by 2 by 6-in. planks laid flat against the interior wales and spaced 18 in. from center to center. For the exterior lagging, $^{7}/_{8}$ by 8-in. tongue-and-groove boards were used, as it was desired to leave the board imprints for architectural effect. In this connection vertical joints in the lagging were considered undesirable and the boards had to be obtained in continuous lengths of 20 ft.

North Carolina pine was unobtainable in lengths of more than 16 ft, and it was necessary to cut down 2 by 8-in. long-leaf pine planks to a thickness of $^{7}/_{8}$ in. The material was, of course, very costly, but the number of re-uses possible owing to its greater strength and better quality brought the additional cost within bounds.

Design and construction of this unique building have proved most interesting. The success of the method evolved has also been gratifying. The work was performed by the Stock Construction Corporation, under the direction of Stanley M. Isaacs, former Borough President of Manhattan; Edgar J. Nathan, Jr., President, Borough of Manhattan; Walter D. Binger, M. Am. Soc. C.E., Commissioner; and Lester C. Hammond, M. Am. Soc. C.E., chief engineer.

Measurement of Cohesive Soil Properties Applied to Engineering Design

By W. S. HOUSEL, M. AM. SOC. C.E.

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICH.

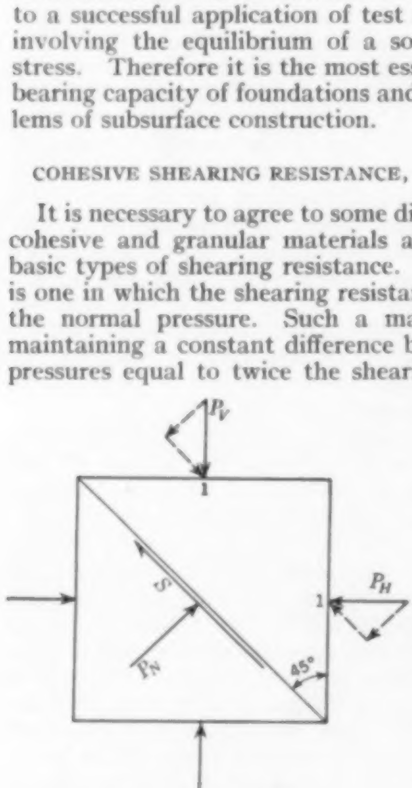
REMARKABLE correlation between data obtained from laboratory tests and the actual behavior of soil foundations has awakened interest in the refinement and development of new testing methods and in the logical interpretation of their results. Professor Housel here analyzes the probable accuracy of shear resistance tests. In his opinion, practicing engineers and educators alike bear the responsibility of consolidating the gains made in the analysis of foundation problems. This article is condensed from a paper presented before the Civil Engineering Division of the S.P.E.E., meeting in 1941 at Ann Arbor, Mich.

EXPLORATION of new fields of testing and analysis properly enough claims much of the time and thought of research workers in soil mechanics. There is, however, the pressing necessity for applying the advances already made to foundation design. In discussing the measurement of soil properties and the use of the resulting data in design, the first objective may well be to demonstrate that the specific knowledge obtained by modern testing methods can be successfully applied in the field. As part of this demonstration it is only being realistic to recognize that inadequacies still exist and to attempt to evaluate their relative importance.

No problem in applying laboratory technique to engineering design appears to be more timely than the measurement of shearing resistance, particularly as this is affected by changes in the soil during the application of load. It is proposed to discuss shearing resistance and its correlation with consolidation. This subject is vital to a successful application of test results to any design involving the equilibrium of a soil mass subjected to stress. Therefore it is the most essential element in the bearing capacity of foundations and in many other problems of subsurface construction.

COHESIVE SHEARING RESISTANCE, OBJECTIVE OF TEST

It is necessary to agree to some differentiation between cohesive and granular materials and to recognize two basic types of shearing resistance. A cohesive material is one in which the shearing resistance is independent of the normal pressure. Such a material is capable of maintaining a constant difference between the principal pressures equal to twice the shearing resistance. This relationship is embodied in the well-known "maximum shear theory," generally considered as most applicable to ductile materials and believed by many to be most acceptable for all homogeneous solids. It may be derived directly from the static equilibrium of an element of mass (Fig. 1).



$$S \times \frac{1}{0.707} = 0.707\,P_V - 0.707\,P_H$$
$$S = \tfrac{1}{2}(P_V - P_H)$$

FIG. 1. CRITERION OF FAILURE FOR COHESIVE MATERIALS

Such a theory presupposes that the specimen will suffer no significant change in physical properties during loading. Considerable complication may result from this source in predicting soil behavior in terms of shearing resistance. The relative importance of such changes and methods of including them in design calculations are subjects of much difference of opinion. It will first be assumed that such changes are negligible and that at least some soils may be treated as purely cohesive materials. Shearing resistance may then be measured at zero normal pressure.

A procedure used at the University of Michigan for cohesive soils involves an efficient and relatively economical method of sampling as well as a simplification of the laboratory procedure. Schematic diagrams of two types of equipment used there to measure shearing resistance of soil are shown in Fig. 2. The major difference is in the size of the shear cylinders, the one on the left having a cross-sectional area of approximately 1.5 sq in., and the other, of 16 sq in. Provision is made in both cases for the application of normal pressure to the specimen, so that the equipment can be used for either cohesive or granular soils. Normal pressure is not used in this first test.

The sampling makes use of the usual boring methods in which a small-diameter boring is made either with or without a casing, and samples are obtained by driving a core barrel into the undisturbed soil at the bottom of the boring. The core barrel used contains an inner liner of metal divided into sections. When the core barrel and sample have been withdrawn from the ground, the inner liner and sample may be taken from the core barrel. The sample is then inserted in a metal container and the ends sealed for shipment to the laboratory.

The next step is illustrated in Fig. 3. Three sections of the core still contained in the segmental liner are slipped into a shear cylinder and secured in position. The support of the center section is then removed and

TABLE I. SUMMARY OF PHYSICAL CHARACTERISTICS OF CLAY SAMPLE

SOIL CHARACTERISTICS	PERCENTAGE	A.S.T.M. DESIGNATION
Moisture content	28.8 dry wt.	D 427-39
Shrinkage limit	15.9 dry wt.	D 427-39
Liquid limit	31.6 dry wt.	D 423-39
Plastic limit	16.0 dry wt.	D 424-39
Shrinkage ratio	1.85 dry wt.	D 427-39
Apparent specific gravity	2.71 dry wt.	Departmental method
Dry-bulk specific gravity	1.92 dry wt.	Departmental method
Mechanical analysis:		
Gravel	2.0 dry wt.	D 422-39
Sand	15.0 dry wt.	D 422-39
Silt	38.0 dry wt.	D 422-39
Clay	45.0 dry wt.	D 422-39
Volumetric analysis:		
Solids	53.6 tot. vol.	Departmental method
Liquids	44.9 tot. vol.	Departmental method
Air	1.5 tot. vol.	Departmental method

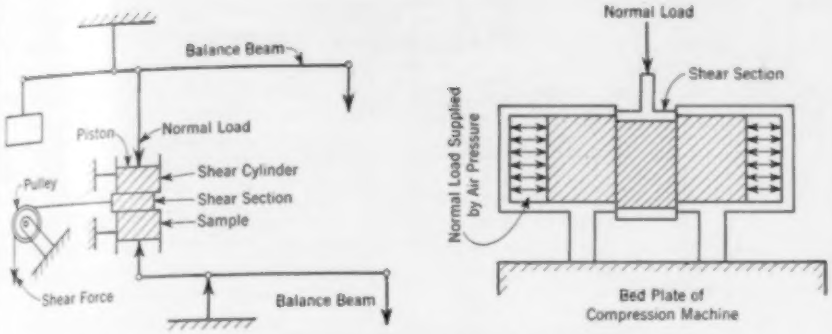


FIG. 2. SCHEMATIC DIAGRAM OF SHEAR TEST WITH SMALL AND LARGE SHEAR CYLINDERS

successive load increments are applied, thus subjecting the sample to direct transverse shear. The shearing displacement is measured by a dial gage and the loading is maintained until continued progressive displacement occurs, indicating the yield value of the soil.

ILLUSTRATIVE TEST TO DISCOVER PHYSICAL CHARACTERISTICS OF SOIL FROM DETROIT AREA

When the shearing resistance of soil not in this first classification is measured at varying normal pressure, the results differ, depending upon the initial density of the soil, its texture, the amount of normal pressure applied, the duration of the normal pressure, and the rate at which the shearing force is applied. The results of a test conducted at the University of Michigan may be used for illustration (Fig. 4).

The clay tested was obtained in Detroit and has the physical characteristics shown in Table I. Series A specimens were consolidated at a pressure of 41.6 lb per sq in., the maximum used in any test. The shearing resistance was then determined at decreased normal pressures as shown. Series B specimens were consolidated at variable normal pressures, which were then maintained during the shear test.

In analyzing the data of Fig 4, it seems entirely logical to interpret the consolidation effects in terms of relative density. Also, such an analysis must recognize that shearing resistance, whether due to cohesion or internal friction, should conform to the accepted definitions for a material that remains unchanged during loading. Series A conforms to this condition, being preconsolidated to a constant density as verified by final check tests. The increase in shearing resistance as a function of normal pressure is the true measure of the internal friction developed. It is represented by an angle of internal friction, ϕ, of slightly more than 2°. This small angle indicates an increase in shearing resistance of less than 0.4 lb for each 10 lb per sq in. of normal pressure. Whether or not this small increase is negligible in engineering design may be debatable, but it certainly is smaller than the probable variations due to any one of several

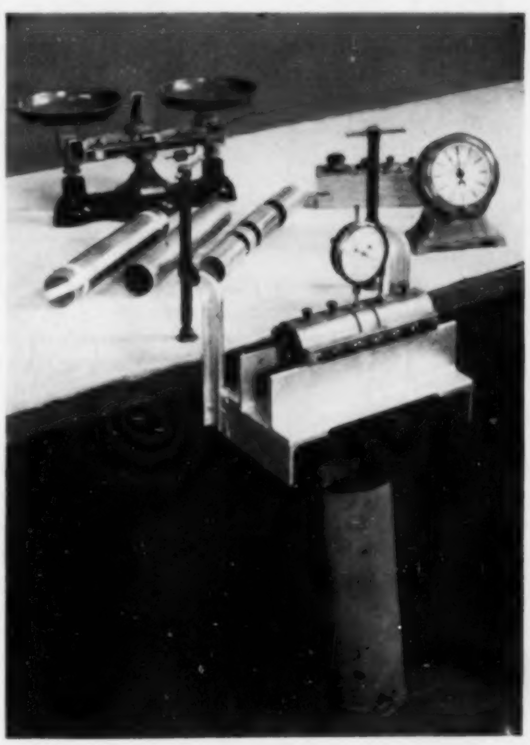


FIG. 3. EQUIPMENT FOR TRANSVERSE SHEAR TEST OF COHESIVE MATERIALS

sources of error involved in sampling and testing.

Series B represents shear tests at variable density and normal pressure. These shears show a wide variation from those in Series A. In discussing these data it should be kept in mind that the samples are disturbed and have been mixed previous to test at a moisture content approximating the liquid limit of the soil. It should also be recalled that the soil is 45% clay, 38% silt, and only 17% sand. The increase in shearing resistance for the full range of normal pressure involves, in addition to true internal friction, those changes which would decrease voids by approximately 7.5% of the volume.

Changing void content must be considered apart from internal friction in the accepted sense. The decrease in voids may show itself in two ways: (1) by an increase in cohesion due to the squeezing out of moisture; and (2) by an increase in internal friction due to closer packing of at least the granular portion of the soil mass.

Shearing resistance varies through two distinct stages rather than one continuous transition. The first stage at low normal pressures shows a somewhat greater change in the percentage of voids but a relatively small change in shearing resistance, indicated by an apparent angle of friction, ϕ_1, of slightly less than 2°. The second stage at higher normal pressures shows a smaller rate of decrease in voids but a considerably larger rate of increase in shearing resistance, equivalent to an apparent angle of friction, ϕ', of more than 7°.

INTERNAL FRICTION INCREASES APPARENT SHEAR STRENGTH

The two separate stages of behavior make possible some basis for analysis. In the first stage of variation with lower normal pressures and higher percentages of voids, there is no internal friction and the increase in shear is due entirely to increased cohesion. The apparent angle ϕ_1 should not then be included as a part of the true internal friction.

During the second stage, continued increase in cohesion due to decreasing void content may be estimated from the behavior of the first stage. The apparent angle ϕ_1 of slightly less than 2° has been accepted as the best estimate of this contributing factor. The most obvious source of the higher rate of increase in shearing resistance in the second stage is the appearance of some internal friction. That part of the increase due to true internal friction has been taken from Series A and amounts of angle ϕ of slightly more than 2° maximum. It leaves as the balance an increase equivalent to an apparent angle of friction, ϕ_2, of 3.3°. This portion of the increase results from closer packing in the second stage.

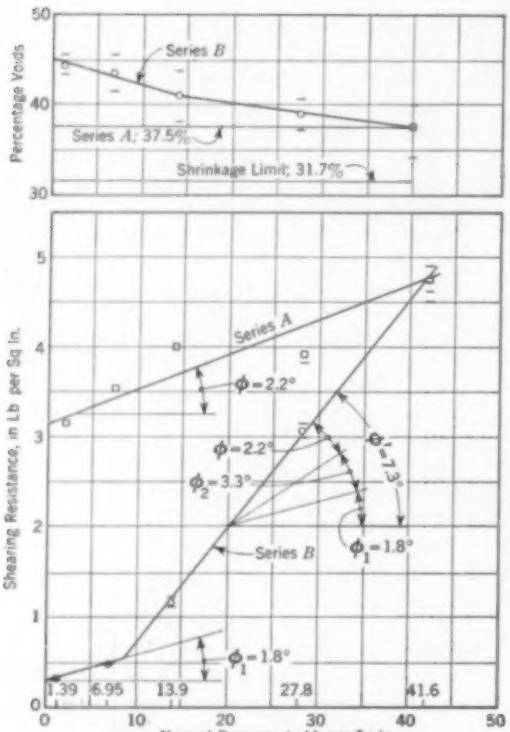


FIG. 4. RESULTS OF TWO SERIES OF SHEAR TESTS PERFORMED AT VARYING NORMAL PRESSURE

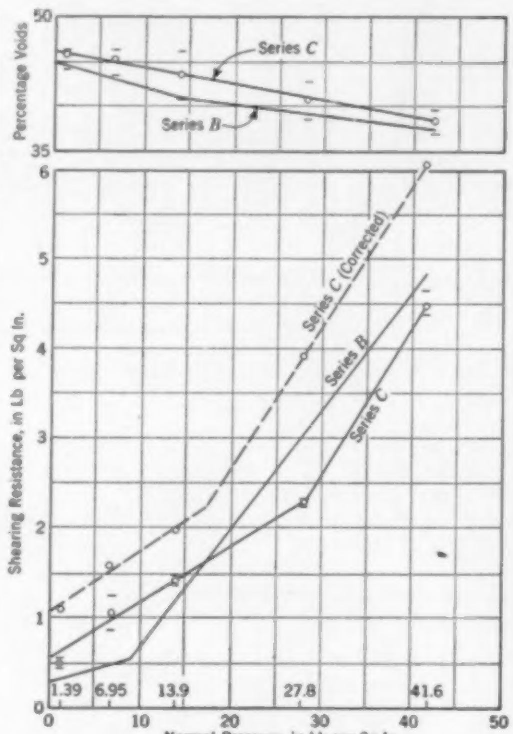


FIG. 5. RESULTS FROM RAPID SHEAR TESTS COMPARED WITH STATIC SHEARING RESISTANCE

The data presented in Fig. 4 appear to justify three conclusions:

1. The maximum value of the true angle of internal friction is between 2° and 3°.

2. Most of the increase in shearing resistance is due to increased density. Resulting increased cohesion would be equivalent to an apparent angle of friction of approximately 2°. Resulting increased internal friction is equivalent to an apparent angle of friction of between 3° and 4°, or somewhat more than the true angle of internal friction.

3. The maximum increase in shearing resistance combining all factors is equivalent to an apparent angle of internal friction, ϕ', of between 7° and 8°. This would amount to an increase in shearing resistance of about 1 lb for each 8 lb per sq in. of normal pressure. While this may not be negligible either in laboratory testing or engineering design, it is doubtful if the accuracy in representative sampling or in soil testing is greater than 10%, which is of about the same order of magnitude.

RAPID SHEAR TEST WIDELY USED

One of the more common methods of avoiding consolidation effects in shearing resistance measurements is the rapid shear test. Such a series of tests is shown in Fig. 5 and designated as Series C. These tests were conducted with the same soil and same procedure as Series B, which is again shown for comparison, except that the shearing load was applied at a continuous rate. The load per minute was selected as about 10% of the anticipated yield value. These rapid shear tests resulted in complete shear failure in approximately 10 minutes.

The soil was mixed at the liquid limit and preconsolidated as in Series B. The comparison between Series B and C then should reflect only the variation caused by the more rapid application of the load. The specimens in Series C averaged approximately 2% higher voids than Series B, as shown at the top of the figure.

Before comparing the shear values of rapid and slow tests, it was considered necessary to correct Series C by reducing the void content to that of Series B, with the corresponding increase in shearing resistance. The corrected Series C is shown by the dashed lines and appears to afford a more logical comparison. It would appear that in the first stage, where cohesion effects predominate, the rapid shear tests may result in measured shear values two or three times as large as those obtained from the slow shear test. In the second stage, where frictional effects predominate, the disparity is much smaller.

That the dynamic resistance of cohesive materials may be large is borne out by analysis of rates of settlement of full-sized structures. For illustration, the results of a settlement analysis of a large power house are shown in Fig. 6. These data are based on levels taken over a period of some 15 years and are typical of several such analyses made by the writer.

RAPID SHEAR TESTS MAY MISLEAD THE OBSERVER

The significant feature in Fig. 6 is the linear relationship between rate of settlement and applied pressure. The intercept on the vertical axis corresponds with the bearing-capacity limit at the yield value of the soil. In this case it is approximately 3,200 lb per sq ft, while the value computed from shearing resistance tests is 2,900 lb per sq ft. The maximum observed rate of settlement occurs at a maximum pressure of approximately 6,000 lb per sq ft and represents an overload ratio of approximately 2. The rate of settlement is also a function of the volume of material involved and, in the case of a large soil mass, is surprisingly small. The significant fact is, however, that there is a large range of stress in excess of the yield point in which the shearing resistance is impermanent. Thus rapid shear tests may give a result entirely too high.

Several sources of difficulty are involved when shearing resistance tests are made with variable normal pressure. First, when cohesive materials are consolidated

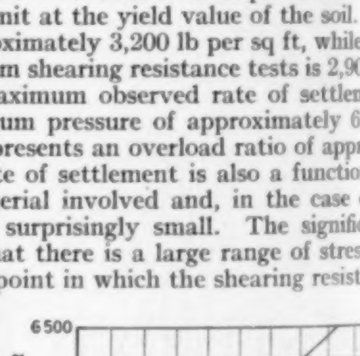


FIG. 6. ANALYSIS OF SETTLEMENT RATES OF POWER HOUSE

within the usual range of applied pressure, it appears that the sum total of consolidation effects may actually be less than other sources of experimental error. Second, the amount of the true internal friction is even less than the consolidation effects. Third, the attempt to eliminate consolidation by rapid shear tests introduces a probable error much greater than the combination of all consolidation effects.

Another consideration is the accuracy with which conditions of consolidation of a relatively small sample in the laboratory can be compared with conditions in a soil mass in the field. In the clay deposits typical of the area bordering the Great Lakes many, if not most, of the deposits consist of a relatively homogeneous mass of clay from the surface to underlying hardpan, or rock. Quite frequently a deposit is sandwiched between a highly impervious hardpan at the bottom and a surface layer compacted by evaporation or natural soil-forming processes. Under these conditions the greater portion of the clay mass has a moisture content approximating that of the time of deposition and certainly bearing no relation to the static pressure of the superimposed overburden. Consolidation has not taken place and the moisture contents are frequently as great as the liquid limit and higher.

Under such conditions the relative importance of including normal pressure as a part of shear testing becomes of even less importance. The elimination of normal pressure then avoids changing void content and eliminates the necessity for encountering the even greater uncertainties of the rapid shear test.

TEST EXPERIENCE JUSTIFIES METHOD

Several examples may be cited to corroborate the experience of the writer. One was given by Dr. Terzaghi in a discussion of embankment failures presented at the 1938 Annual Meeting of the Highway Research Board. He stated that in the investigation of a number of earth slides in Bulgaria it was found that the shearing resistance mobilized on the failure surface agreed very closely with the shearing resistance found at zero normal pressure determined by shear tests. Similar results were obtained by Swedish engineers in their investigation of earth slides.

Procedure with zero normal pressure has been the practice in routine shear testing in the University of Michigan soil mechanics laboratory for the past 10 years. During this period a considerable backlog of experience has been accumulated which can be drawn upon to test the soundness of such practice. Several examples may serve to compare the field behavior of large structures with the behavior anticipated from shear tests.

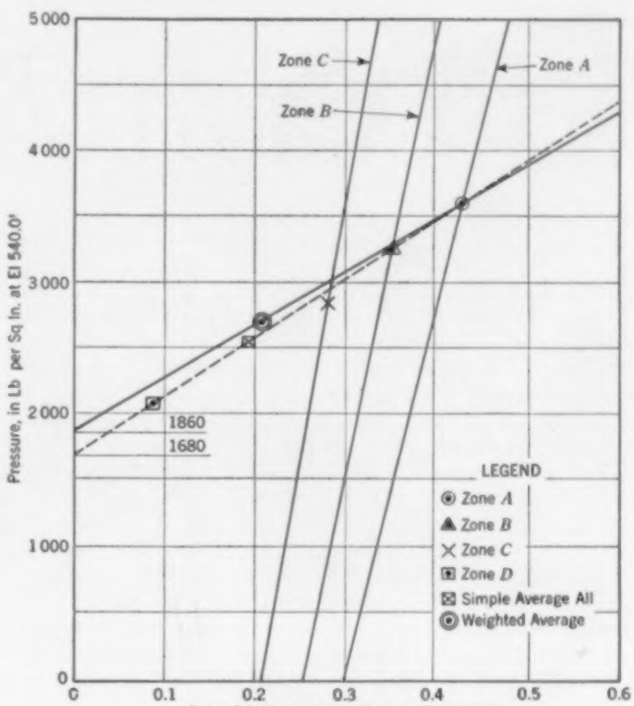


FIG. 8. GRAPH OF CORRELATION OF RATE OF SETTLEMENT AND PRESSURE DISTRIBUTION

A heavy church tower in Toledo, Ohio, had settled badly and litigation had arisen, as the owners attempted to place responsibility for the damage on a contractor who had constructed a large sewer in tunnel nearby (Fig. 7). The computed bearing capacity varied from 2,700 to 3,100 lb per sq ft in one boring, and from 2,000 to 3,800 lb per sq ft in another. These data were introduced as evidence in the suit and were the basis for a verdict in favor of the contractor.

A second example is the analysis of settlement of a power house mat. A correlation of pressure and rate of settlement similar to that previously discussed is shown in Fig. 8. Again there is a well-defined linear relation between pressure and rate of settlement in various zones of the loaded foundation with a bearing-capacity limit of 1,680 or 1,860 lb per sq ft, depending on the method used in averaging pressure areas. Load tests conducted on the soft clay stratum indicated a bearing-capacity limit of approximately 2,300 lb per sq ft, while the bearing value computed from shearing resistance tests was 1,800 lb per sq ft.

There has been some reluctance on the part of commercial interests to accept the basic physical tests that have been successfully used in other fields. Considering the increasing importance of the rational approach to difficult foundation problems, it is fortunate that a healthy interest in soil mechanics has developed. This interest has provided well qualified scientific investigators who are prepared to attack these problems from an impartial viewpoint.

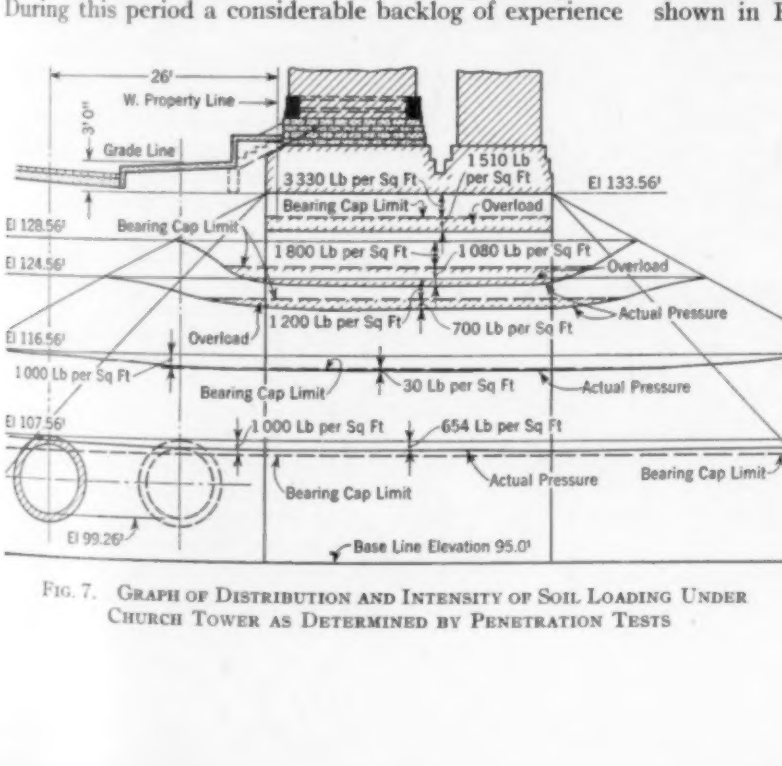


FIG. 7. GRAPH OF DISTRIBUTION AND INTENSITY OF SOIL LOADING UNDER CHURCH TOWER AS DETERMINED BY PENETRATION TESTS

Effect of Defense Projects on City Plan of Louisville, Ky.

By Carl Berg

Engineer-Secretary, City Planning and Zoning Commission, Louisville, Ky.

Expenditure of 170 millions on defense projects in one area, even around a center as large as Louisville, is bound to have far-reaching effects. How they impinged on the comprehensive city planning proposals is explained by Mr. Berg. After discussing the local problems of slums, shifting population, and economic dislocations, he shows the impact of the war, particularly as it has affected housing and transportation. This case study of an important planning problem is condensed from a paper presented before the City Planning Division session at the Society's January 1942 meeting in New York.

Louisville was late, as compared with other cities, in establishing a city plan. It was not until 1930 and 1931 that ordinances were adopted for the several subdivisions of the plan, including major streets, transportation, transit, recreation, riverfront, airports, and zoning. The territorial jurisdiction includes the incorporated city and an area extending five miles from the boundary line, in which subdivision control regulations are in effect.

Like all other American cities, Louisville then became a victim of the general depression. While the subsequent physical improvements have not been spectacular, what has been accomplished has been according to the city plan. Before the major street plan and subdivision control regulations went into effect, there was little or no supervision of the platting of land for subdivision purposes; streets were laid out and improved in a haphazard manner, creating problems which the city is struggling with today and attempting to correct.

GAINS IMPLEMENT COMPREHENSIVE PLAN

Since the plan went into effect, the Planning Commission has approved 116 subdivision plats comprising 4,790 lots. A total of 53 miles of new streets and parkways have been dedicated or widened according to the comprehensive plan. The beneficial effect of zoning in protecting residential neighborhoods and in locating commercial and industrial establishments is continually gaining public support for the comprehensive city plan. It has had a stabilizing influence on real estate values.

Also, in conformity with the plan, 22 grade crossing eliminations have been constructed within the city limits and three in the county within five miles of the city. Re-routings of streetcar transit lines have been made in conformity with the transit plan. Three parks and playgrounds have been established and developed. Following the 1937 flood, 122 parcels of land located in the inundated area have been acquired by the Park Board.

One new auxiliary airport established because of the conversion of Bowman Field into a bomber base was developed by the Louisville and Jefferson County Air Board. It was located approximately where recommended on the comprehensive plan. However, its development caused the blocking of the extension of one proposed major highway and one proposed parkway.

The Planning Commission co-operated with other organizations in securing for Louisville six housing projects. Two of these, built under the PWA, were located on vacant land; three, built under the USHA, were in the nature of slum clearance. One other USHA project was built on vacant land. Through the demolition of substandard dwellings located elsewhere in the city, the location of those projects on vacant land was considered justified.

SLUM PROBLEM IS DIFFICULT

Louisville, like all other cities, is faced with the problem of decentralization and the development of the area outside its limits. This has resulted in an alarming reduction of property values in the central part of the city, which is degenerating into blighted and slum areas. Tax delinquency has increased and many properties are being taken over by the city for non-payment of taxes. Many buildings are being demolished to escape the payment of taxes, thus reducing the city's revenues. As the city's expenses are continually increasing with the public demand for additional services, an increasing burden falls upon the property which is still able to pay taxes.

Because of the lack of proper control over the design and development of subdivisions in suburban areas, and the lack of building codes and zoning regulations, new slums and blighted districts are being created outside the city limits. Also, failure to provide proper sewage disposal is threatening the health of these outlying communities. Masses of people, motivated by the desire for light, air, and room, and aided by inexpensive automobile transportation, moved out of the central area, thereby escaping the responsibility of taxes while at the same time enjoying the benefits which the city has to offer.

At the same time, the increased traffic leading to these suburban areas has created demands for wide and expensive arterial streets. The city, in short, while decaying at the core, is subsidizing the development of its periphery, which does not share the burden and responsibility of its existence. Instead of being a compact unit, Louisville has expanded to such an extent that it cannot economically provide the facilities which its inhabitants demand and deserve. The defense effort spurred this movement, as the FHA made money easily available for the construction of homes for sale or for rent on the outskirts.

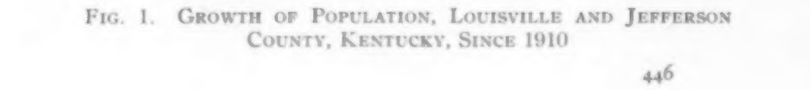


Fig. 1. Growth of Population, Louisville and Jefferson County, Kentucky, Since 1910

In Fig. 1 the comparative growth of population within the city limits of Louisville and Jefferson County is graphically shown. Percentages, as given in the small boxes, indicate the growth during the preceding decade. Between 1920 and 1930 the city annexed a considerable portion of the county. In spite of this, the county also had an increase. Casual studies, by the Louisville Board of Trade, of population trends under national defense indicate that during 1941 Jefferson County's population has increased by 14,631 and that 5,364 have taken up their homes within the city boundaries and 9,267 outside.

Other studies (Fig. 2) compare subdivision activity inside and outside the city in the 10-year period during which the Planning Commission has had control over the establishment of subdivisions. It is clear that the trend of population is away from the city to the suburbs.

After the low ebb of 1933, Louisville gradually improved its economic condition. Then the defense activity started about August 1940. Various war industries were established in or near Louisville, some across the Ohio River in Indiana. Total improvements amounted to something like $135,000,000, and included a huge powder plant, a bag plant, Quartermaster's Depot, Naval Ordnance, private manufacturing, and public utilities. Military posts and airports added another $25,000,000. Approximately $170,000,000 was projected to be spent on construction in the area outside of the city. Also, at least 150 established industries within the city limits have, or have had, defense contracts or subcontracts.

HEAVY INTERSECTING TRAFFIC CONVERGES AT BRIDGE APPROACH IN RUSH HOURS
Municipal Bridge Appears in Background

HOUSING FOR DEFENSE WORKERS

At the peak, close to 34,000 construction workers were employed in adjacent Indiana and a great proportion of these tried to find living quarters in the city of Louisville. Almost all available living space was taken, and in some cases lodging houses were established in which men slept in beds by shifts. There just was not room for everybody. Trailer camps sprang up near the plants and on the outskirts of the city; sanitary conditions were unspeakable. At least 1,000 additional units were provided by conversion. Probably half of these were of a temporary nature, and may possibly revert to their original form after the emergency has passed. Approximately 4,000 new single-family dwellings were built in Louisville and Jefferson County during 1941.

Meanwhile the Federal Works Agency established a Defense Housing Project outside the city limits for the primary purpose of providing housing for non-commissioned officers at Bowman Field, approximately three miles from the project. There are no direct public transportation connections. Before the project was begun, representatives of the FWA assured the Planning Commission and other city officials that such projects would be built in conformity with all existing local laws, but when the project was about to be built it was discovered that a proposed major street was being blocked. This street was considered of great importance by the Commission as it afforded a direct connection between Bowman Field and the new auxiliary airport which was in the process of construction.

Since that time the establishment of an Army hospital has closed one major highway leading into the city and effectively blocked the extension of a major street. Also the establishment of a reconsignment depot has blocked another major highway shown on the comprehensive plan.

In spite of the objections of the Commission and the failure of the Government to negotiate, the Defense Housing Project was built, and upon advice of the Law Department the Commission refrained from taking injunctive action against the FWA. To quote the Director of Law of the City of Louisville, "Unless the matter can be remedied by direct negotiation with the proper authorities in Washington, the City is without remedy. It is indeed to be hoped that in this and future cases a more sympathetic attitude will be taken toward local regulations by the federal authorities as it is only by co-operation between local and general government that the processes of orderly government can be maintained."

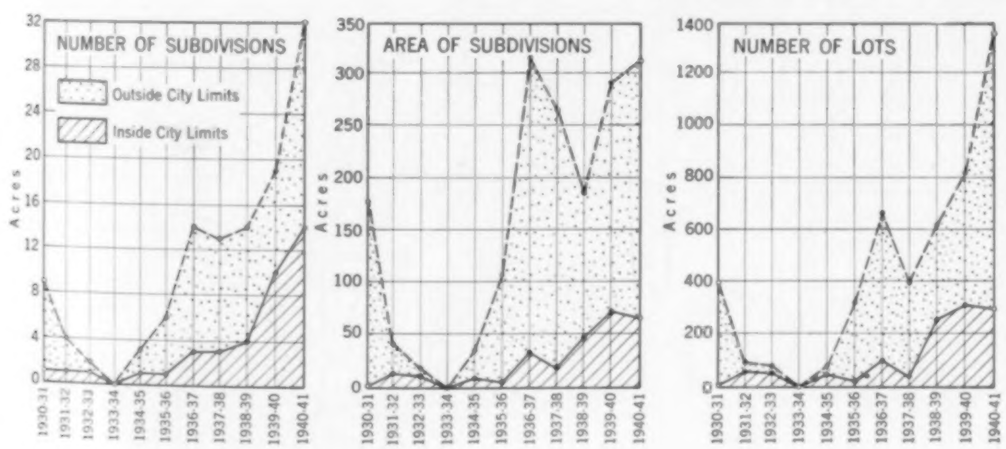


FIG. 2. COMPARISON OF SUBDIVISION ACTIVITY INSIDE AND OUTSIDE OF LOUISVILLE CITY LIMITS

Street Congestion Persists Two Blocks from the Bridge Approach
Most of the Private Cars Carry Workers in Defense Industries Across the Ohio in Indiana

The project, which was ready for occupancy on November 11, 1941, contained 58 structures with 250 units for rent. It had 75 vacancies as of January 15, 1942. The project now may be rented to defense workers. Local real estate and public authorities are not enthusiastic over this type of development. They believe that it will cause neighborhood values to decline and will have little or no market value after the war. They feel it is better handled by private enterprise, subsidized if necessary.

In an attempt to provide additional housing units by converting existing residences, the Planning Commission was requested to recommend changes in the zoning ordinance to reduce areas zoned for single-family uses so as to permit multiple-family residences. To date these changes have not been made. Rumor has it that if private builders are not able to provide the necessary dwelling facilities for defense workers, the government will, by constructing additional housing projects.

Since the city is in no financial position to install sewers completely in new subdivisions and since the regulations and policies of the WPA and the FHA are conflicting, the development of several subdivisions to house defense workers has been held up or retarded by lack of proper sewerage. Subdividers and builders have not been able to conform to the requirements of these two agencies. In the meantime, septic tanks are being installed in some developments, which are a potential menace to health.

Traffic Becomes Complicated

The great increase of traffic due to defense construction in Indiana crossing the Municipal Bridge and entering the north end of the business district is shown in Fig. 3. While automobile registration has been steadily increasing, traffic counts made in 1937 and 1940 showed a tendency for the volume of traffic within the business district to decrease.

It can easily be understood how the great increase in bridge patronage affected traffic conditions in the business district. This was particularly true since construction shifts were so timed that the peak of the vehicles carrying defense workers arrived at the business district during periods when normally the streets were already taxed almost to capacity. In an attempt to untangle the traffic jams so caused, one-way traffic, no-parking rules, and no-turning regulations were adopted. Additional police were stationed to attempt to keep the traffic moving.

As for the parking problem, it was seriously aggravated not only in downtown areas but also in residential sections where the workers lived. Army transports passing through the city and the trucking of defense materials have added to the difficulty, owing to the location of the bridges across the Ohio River and the lack of by-pass highways.

Since the peak of construction has been passed, the traffic situation has simmered down almost to normal. The beneficial results of such an aggravated condition will probably result in the widening of certain strategic streets, the establishment of by-pass highways, some provision for additional parking in the downtown area, and improvement in the methods of handling volumes of traffic at the busiest periods of the day.

Defense Helps General Economic Situation in Louisville

With the influx of masses of new workers and the payment of additional and higher wages, Louisville is now enjoying a general increase in prosperity and business activity. This is clearly shown in the increase of bank deposits from $219,000,000 in 1940 to $277,000,000 in 1941, or a gain of 21%. Also, the city has had a 30% advance in retail trade in 1941. To quote the Secretary of the Real Estate Board, "The over-all increase in rentals caused by defense activities has been about 10% and this has now [January 1942] leveled off at that point."

Thus it is clear that Louisville has benefited economically from the establishment of defense industries in the area. Its greatest fear now is as to what will result after the war, when adjustments must be made back to normal peacetime activity. That challenge must be met in the course of time. Will we and our government be able to make proper plans for preserving that democracy for which we are fighting today?

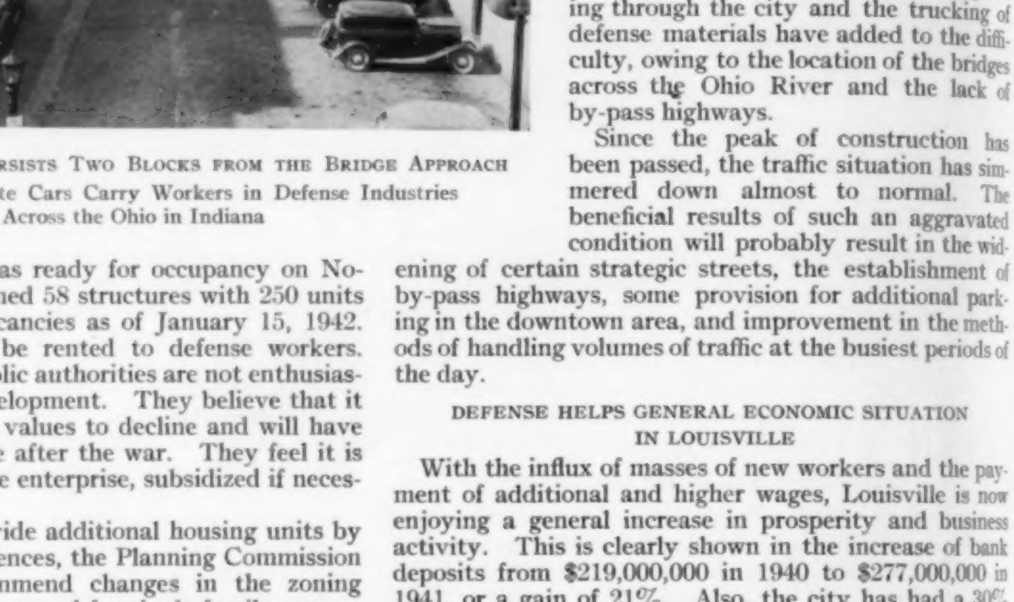


Fig. 3. Vehicles Crossing Municipal Bridge, from Louisville, Ky., to Jeffersonville, Ind., 1930–1941

Merriman Dam and Delaware Aqueduct

Construction Progress and Methods on Water Supply Project for New York City

By Roger W. Armstrong, M. Am. Soc. C.E.

Deputy Chief Engineer, Board of Water Supply, City of New York, N.Y.

Urgent need of New York City for an additional water supply has given impetus to the development of the water storage and transportation works of the Delaware system. As planned, the drainage basins of three Catskill Mountain streams will add 540 mgd, or more than 50%, to existing sources. The primary unit for impounding the new supply is the Merriman Dam on Rondout Creek. This is well under way, while the 85-mile pressure tunnel leading to New York City is nearing completion. As explained in this paper, revised from its original presentation before the Sanitary Engineering Division at the Society's Annual Meeting in January, construction methods on this first stage of the new system are interesting and unique.

Since early in 1937, New York City's Board of Water Supply has been engaged in the development of the Delaware system of water supply resources. Rondout Creek, Neversink River, and the East Branch of the Delaware River are expected to yield 100 mgd, 70 mgd, and 370 mgd, respectively. Rondout Reservoir will eventually be the collection point whence water from the three sources will pass through the Delaware Aqueduct to New York City. No provision is included in this system for new reservoirs near the city. Instead, use will be made of existing reservoirs both for emergency storage and for equalizing the distribution draft.

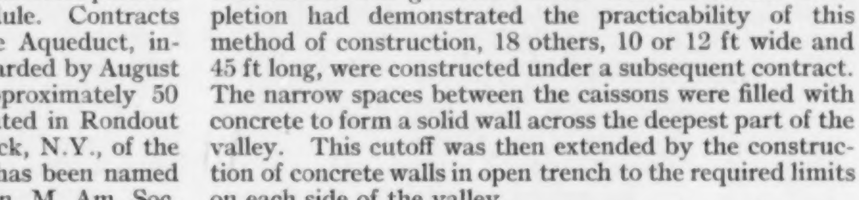
Water from Rondout Creek, nearest of the three sources, will be ready for delivery in the shortest possible time, according to the construction schedule. Contracts for this reservoir and for the Delaware Aqueduct, involving some $170,000,000, had been awarded by August 1939. Designed for the storage of approximately 50 billion gallons, the reservoir will be created in Rondout Valley by the construction at Lackawack, N.Y., of the Merriman Dam. This earth structure has been named in honor of the late Thaddeus Merriman, M. Am. Soc. C.E., who as chief engineer, and later as consulting engineer, of the New York Board of Water Supply, was largely responsible for the conception and the start of construction of the Delaware Water Supply System.

Stretching 2,400 ft between abutments to a maximum height of 200 ft, this dam will attain a maximum base width of 1,400 ft. Except for heavy blankets of stone on both upstream and downstream faces, it will be constructed entirely of one class of material. This selected earth, spread in 7-in. layers, will be compacted by sheepsfoot rollers. The total volume is estimated at 6,700,000 cu yd, of which 5,600,000 will be rolled embankment.

At the dam site the Rondout Valley is a U-shaped gorge in the horizontally bedded Catskill formation of shales and sandstones, partially filled with deposits of heterogeneous glacial material which vary in depth from a maximum of 180 ft in the center of the valley to 20 to 30 ft on the sides. Some of this material overlying the rock was known to be water bearing, and artesian flows were encountered from the lowest stratum.

The security of a high earth embankment on this site was obviously dependent on a tight cutoff wall extending through the overburden into sound bedrock, and the construction of a wall of such height through water-bearing material presented serious difficulties. The deepest portion of the cutoff wall was designed as a series of pneumatic caissons in which pumping units could be operated to lower the ground water. By this means the air pressure required to exclude water from the working chambers during sinking could be kept within the limits prescribed by New York State for work under compressed air. Two exploratory caissons 38 ft long and 15 ft wide were first sunk where the depth of overburden was greatest. After their successful completion had demonstrated the practicability of this method of construction, 18 others, 10 or 12 ft wide and 45 ft long, were constructed under a subsequent contract. The narrow spaces between the caissons were filled with concrete to form a solid wall across the deepest part of the valley. This cutoff was then extended by the construction of concrete walls in open trench to the required limits on each side of the valley.

In providing for the control and diversion of the flow in Rondout Creek during the construction of the dam,



Progress on Merriman Dam

Sheeted Open Cut in Foreground and Caisson Construction for Cutoff Wall at Right

Completed Cutoff Wall for Merriman Dam

use was made as far as possible of structures that would eventually form a part of the permanent construction. The works designed for this purpose consisted of a low earth dike, which will be incorporated in the main dam as its upstream toe, and a rock tunnel in the west abutment of the dam, extending from an intake about 500 ft above the diversion dike to a point of discharge well below the working area.

This diversion dike is approximately 1,400 ft long on top and 55 ft high at the bed of the creek. The embankment was formed of selected material compacted by sheepsfoot rollers and faced on the upstream slope with heavy riprap. Its construction furthered the completion of the main structure not only by forming a part of it, but also by providing an opportunity for study of the available embankment material and its suitability for use under the proposed methods of compaction.

The diversion tunnel is a circular concrete-lined bore 30 ft in finished diameter and 2,450 ft long. Subsequent to its use in by-passing the waters of Rondout Creek during the construction of the Merriman Dam, its upstream end will be closed by a concrete plug and the remaining portion will become a conduit for the disposal of water passing over the spillway. This water will enter the tunnel through an inclined shaft at the end of the spillway channel.

At the end of the year 1941, all preliminary work in connection with the Merriman Dam had been completed. The cutoff wall had been constructed for the entire length of the dam; a concrete core wall which will extend above the cutoff wall into the rolled embankment for about one-third of its height had been substantially completed; and the contractor's processing plant for embankment material had been installed and a small quantity of rolled embankment placed.

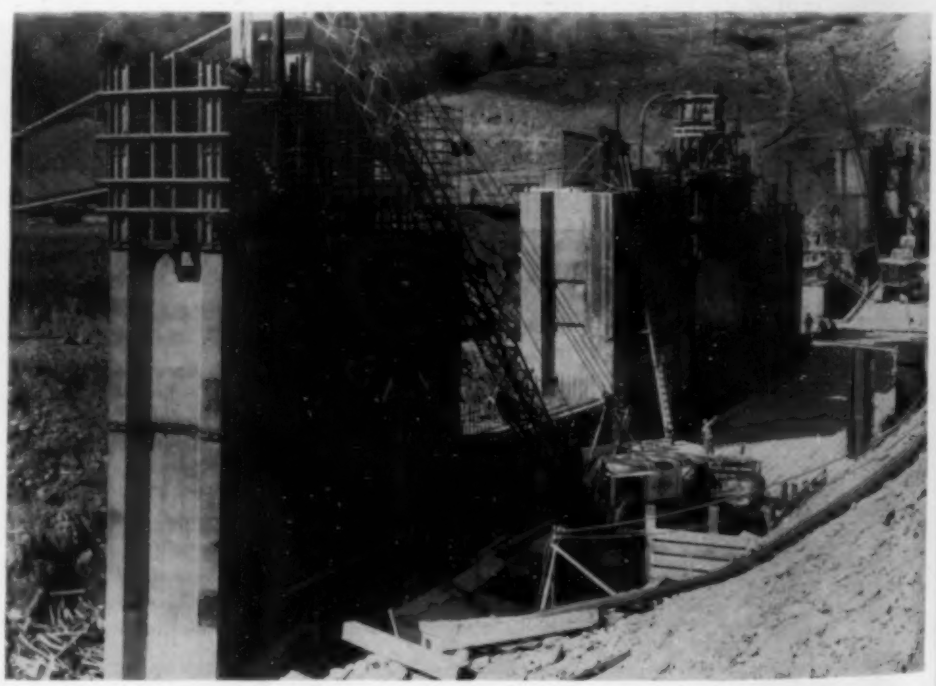
The Delaware Aqueduct is a pressure tunnel 85 miles in length from its intake at the Rondout Reservoir to its southerly terminal at Hill View Reservoir, just north of the New York City line. Its location and dimensions, and the functions of the several shafts in the completed system, were described in Civil Engineering for September 1938, page 581.

Construction of the aqueduct, which was started with the award of the first contracts for shaft construction in 1937, is now nearing completion. All the excavation, except about 3,000 ft, has been done and nearly all the 85 miles of excavated tunnel have been lined. The outstanding features of this construction work have been the substantial plant installed by the contractors, the extensive use of mechanical equipment, and the organizations developed for the attainment of rapid progress.

In the excavation of the tunnel there was a great similarity in the general methods used on all contracts. The drilling of full-face headings from drill carriages or jumbos, the blasting by delayed detonators, the removal and loading of muck into cars by mechanical excavators, and the hoisting of muck to the surface in large automatic dumping skips, were practically universal procedure. Electric traction, generally by storage-battery locomotives, was used on all contracts, but locomotives operated by diesel engines were also employed for this purpose on one contract. Power for the operation of compressors, hoists, pumps, blowers, battery charging stations, and other equipment was furnished in all cases by the local electric power companies.

Improved Equipment Makes Rapid Progress Possible

With this and other improved tunneling equipment, the several contractors for tunnel construction were able to attain rates of progress in excavation which were in excess of any heretofore made in this section of the country. The 13-ft 6-in. tunnel was advanced at an average rate of 172 ft per week, the 15-ft tunnel at 141 ft per week, and the 19-ft 6-in. tunnel at 106 ft per week—rates of excavation which were considerably above those upon which the contract progress requirements were based. Rates higher than those mentioned were maintained in good tunneling ground and even in formations which required continuous roof support. On the other hand, zones were encountered in which the rates of advance were appreciably reduced, or in which no progress was made for prolonged periods, varying in duration up



Caissons Forming Cutoff Wall in Various Stages of Construction and Sinking

to a maximum of one year. In these locations, which were generally faulted areas where the rock had been badly shattered and disintegrated, and where large inflows of water were encountered, the normal excavation methods were abandoned and special procedures adapted to the peculiar character of the ground were substituted.

Consolidation of the rock ahead of the excavation by forcing cement grout through drill holes and pipes, or drainage by small drifts driven in advance of the regular excavation, generally facilitated the work in these zones. The excavation was then advanced slowly and carefully, generally by first driving side and top-center drifts and then widening out between them. At the same time whatever support was needed was erected to make the tunnel safe until the final lining was placed. Both concrete and steel were used to support the excavation through these zones of weak rock. In several instances complete outer linings of reinforced concrete were required before the tunnel was considered safe for continuance of the normal tunneling operations.

SEVERAL LINING PROCEDURES FOLLOWED

In contrast to the uniformity that marked plant installations and operating methods employed in the excavation of the tunnel, the plant and methods used by the several contractors for the construction of the tunnel lining showed considerable diversity. In all cases, however, the lining was placed in two operations, the division line being the junction of side walls and invert. On all but one contract the invert was the first portion of the tunnel lining to be placed.

On the majority of the contracts it was the practice to place a considerable length of invert before the remainder of the lining was started. Concrete for the invert was deposited from cars traveling on tracks supported by the bridge which carried the invert forms, or was delivered from the mixer by belt conveyor or pump discharge pipe.

For the construction of the invert, complete forms were employed on only two contracts. The majority of the contractors used no forms other than the side bulk-

Excavation for 19-Ft 6-In. Tunnel in Badly Shattered and Disintegrated Ground

heads which formed the radial joints between the invert and the side walls and which served as guides for the screeds used to shape the top surface of the concrete to a circular form. These bulkheads were attached to a carriage that traveled on the rails set to exact grade on previously built concrete curb walls or piers. After screeding to the required shape, the top surface of the invert was finished by hand troweling.

Concrete for the side walls and arch of the tunnel lining was poured as one operation and was delivered to the forms either by pneumatic placers or by concrete pumps. All concrete was consolidated by the use of electric or mechanical vibrators. Forms were constructed of steel plates supported by rugged structural steel ribs. The forms were designed to collapse onto a structural steel carriage traveling on tracks laid on the invert. On a number of the contracts, the collapsed forms were of such dimensions that they would pass through the expanded sections. Removable steel plates or doors were provided at intervals for access back of the forms. When in position for receiving concrete, the lower edges of the side-wall plates were held firmly to the invert by bolts screwed into sockets set in the invert concrete for that purpose.

Prior to the start of concreting operations, individual inflows of water were piped through the forms, and seepage from wet areas was concentrated behind sheet metal pans attached to the rock and also brought through the forms in pipes. Steel pipes were also incorporated in the roof of the lining at regular intervals and at points of high breakage in the roof to provide means for forcing grout into voids and shrinkage spaces between the concrete lining and the rock.

On several of the contracts the length of side-wall and arch sections was determined by the quantity of material that could be delivered in one shift. Work was then suspended until the concrete had set sufficiently to permit the forms to be moved ahead. On other contracts, the construction of side walls

Tunnel Under Construction, Showing Concrete Side Walls and Steel Roof Support Used Through Faulted Zone

ARCH AND SIDE-WALL FORMS IN PLACE FOR CONCRETE TUNNEL LINING

and arch was carried on continuously for five or six days, a sufficient length of form being provided so that the concrete in the rear section of from would set before the forward section was filled. The rear section was then collapsed, moved through the others, and set up at the forward end.

In general, the tunnel lining is of mass concrete without reinforcement of any kind. Through zones of badly disintegrated rock, however, where the internal pressure and resulting consolidation of the surrounding material might rupture the lining, steel interlinings were incorporated in the concrete and the outer portion of the concrete lining was heavily reinforced.

Portland cement manufactured according to Board of Water Supply specifications, and delivered to the work in bulk, was used for all the concrete. The fine aggregate was either gravel or crushed stone furnished in two sizes, from $^3/_4$ to $1^1/_2$-in., and from $^1/_4$ to $^3/_4$ in., the two being used in the mix in such proportions as to give the greatest density of concrete. Batching at plants in which the materials are proportioned by weight is a contract requirement. The concrete was mixed either on the surface or in the tunnel adjacent to the forms. In both cases, either the mixed concrete or the dry ingredients were delivered to the tunnel through pipes in the shafts provided for this purpose. Mixed concrete was ordinarily transported to the forms in agitator cars, which were operated at the end of the run so that the concrete could be given a final mixing immediately before placing.

ALL VOIDS BEHIND LINING GROUTED

The final operation in the construction of the tunnel lining consisted of the injection of grout through the concrete to fill voids in the dry packing behind the roof support, to fill voids and shrinkage spaces between the concrete and the rock, to cut off inflows of water, and to fill open seams in the rock behind the lining. Grouting was done through the steel pipes previously incorporated in the concrete, or set in holes drilled in the lining. At least two grouting operations were required. The first, using pressures up to approximately 100 lb per sq in., filled the larger voids and shrinkage spaces. The second, using higher pressures, sometimes up to 1,000 lb per sq in., cut off inflows of water and filled the smaller spaces left after the first operation.

In its course from the Rondout Reservoir to the city, the water from Delaware sources will normally pass through the West Branch Reservoir, one of the high-level storage basins of the Croton system; through Kensico Reservoir, the unit of the Catskill system which provides emergency storage near the city; and through Hill View Reservoir, the main distributing reservoir of the Catskill system. However, if it should be found desirable to keep the Delaware water separate from that of the other systems, it may be diverted through tunnels by-passing these reservoirs. Gates in the chambers provided at the entrance to each reservoir direct the flow either into the reservoir or to the by-pass aqueduct.

The gates and valves for regulating the flow, and the venturi meters for measuring it in each section of the aqueduct, are located in chambers at the reservoir outlets. Although varying greatly in detail, all are designed on the same general principles. In each chamber water from the reservoir or the by-pass aqueduct will be admitted to a forebay through sluiceways. In the case of the Rondout chamber, this may be closed off by specially designed leaf gates. At the West Branch and Kensico chambers, batteries of 6 by 15, or 6 by 12-ft sluice gates control the flow. From the forebay the water may be directed into the aqueduct through regulating valves.

STILLING CHAMBERS CONTROL FLOW CHARACTERISTICS

Excess head, available when less than the full capacity of the aqueduct is being drawn, creates energy which is dissipated at the Rondout and West Branch effluent chambers by discharging the draft through nozzles into large stilling chambers. At the Rondout chamber there are also friction losses in about 2,200 ft of inclined tunnel, which has been provided with longitudinal vanes in the invert to increase the wetted surface. At the Kensico effluent chamber, where the head is relatively low, throttling of the regulating valves will take care of the excess heads at low drafts.

Provision is made in each effluent chamber for the installation of chlorinating equipment of sufficient capacity to treat the maximum draft. Adjacent to the Kensico influent chamber, a coagulating plant will be established and equipped with apparatus for introducing coagulants into the water entering the reservoir. Provision is made for aeration of the entire supply. No filtration of Delaware water is contemplated now or in the immediate future, but a chamber has been constructed two miles west of Kensico Reservoir which will permit connection to possible future filters without interruption of normal operations.

The Delaware Water Supply System is being constructed by the Board of Water Supply of the City of New York, of which Charles M. Clark is chief engineer, and Roger W. Armstrong, M. Am. Soc. C.E., deputy chief engineer. The department engineers of the Headquarters, Watershed, Northern, and Eastern departments are, respectively, Harry R. Bouton, Assoc. M. Am. Soc. C.E., James A. Guttridge, M. Am. Soc. C.E., Neil C. Holdredge, M. Am. Soc. C.E., and John M. Fitzgerald.

Developments in Industrial Camouflage

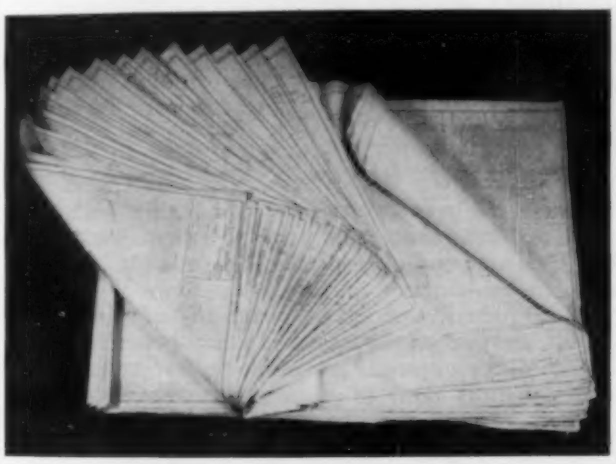
Setting the Stage to Baffle Enemy Bombardiers

By Donald P. Barnes, Assoc. M. Am. Soc. C.E.

Major, Corps of Engineers, U.S.A.: Chief, Camouflage Section, The Engineer Board, Fort Belvoir, Va.

When seen from the air, the factory that has been skillfully masked by engineers schooled in camouflage does not call attention to itself. True, a river, of paint, and an orchard or two seem out of place at a bomber plant, but they may prove to be the most important equipment when the drone overhead comes from Heinkels and not from Boeings. Extensive photographic tests have determined for the Camouflage Section of the Engineer Board which concealment is most effective. Major Barnes weighs the relative value of artificial, as contrasted with natural, disguise for military objectives.

The purpose of any camouflage is to render the subject indistinguishable from its surroundings. For industrial installations, the task is immeasurably simplified if this purpose can be kept in view from the inception of the project. For example, it is simpler to design the exterior of a water works as a residence initially than to attempt disguise after the typical blockhouse has been poured in concrete. It is less expensive to build a machine shop initially in the semblance of apartment dwellings than to await an attack before erecting costly and unconvincing staging. Also, it is better to locate a plant initially in an area that is free from conspicuous landmarks than to be faced later with the perplexing problem of moving a bridge or raising a tent over a 300-ft gas holder in order to eliminate it as a marker.



Product of Engineer's Essential Work in Camouflaging a Large Plant

As yet, few, if any, installations in this country have been laid out and constructed with all-out camouflage in view. A few have been located advantageously to facilitate later camouflage, but most have been constructed either with no thought to the subject or under the impression that the threat was insufficient to warrant the expense. This is not surprising, as there still is no clear way of evaluating, for comparison with camouflage costs, the risk of enemy bombing.

Wide Variation in Costs

Camouflage costs may vary from nothing to an embarrassingly large percentage of the normal plant cost. What can be done without even the intent to camouflage is illustrated in an article that appeared in Civil Engineering for March 1941, "Esthetic Responsibilities of the Engineer," by Harold M. Lewis, M. Am. Soc. C.E., where a New England water works is shown designed as a Colonial residence, and a California sewage disposal plant appears as a kind of Mediterranean architecture.

In one case of a group of shops and office buildings dispersed in heavy woods to take advantage of the forest cover, the cost increment chargeable to camouflage is variously estimated at from 3 to 10%. This increase is attributed to the greater lengths of utilities and to the difficulty of construction operations without injury to the trees. There should be a considerable compensating factor, however, in the reduced costs of clearing and grading and in the improved working conditions. As indicated in the accompanying photographs, these buildings have not been completely camouflaged, but have had their visibility from aerial observation so greatly reduced that relatively little artificial screening would be required to secure complete concealment.

For great war plants within supposed enemy bombing range, large sums have been and are being spent to achieve reduced visibility and confusion of identity. Camouflage contracts for existing single installations may amount to $200,000 or $1,000,000, depending upon the extent of concealment considered practicable and the size of the project. Some plants will cost from $1,000 to $5,000 per occupied acre for combined screening and painting. It is considered by many that 10% of the original cost of an installation may be a reasonable expenditure for camouflage if the plant is very important, if it is in a threatened area, and if there is a fair prospect that some success can be achieved.

Priority, Too, in Camouflage

This explains in part why all-out camouflage cannot be required immediately for every installation with an important war function. The hundreds of factories, refineries, arsenals, shipping centers, and utilities near the coast lines can be treated only in limited categories at a time. Tactical airfields of course come first, with key aircraft factories a close second. These two categories alone are momentarily taxing the pigment pro-

Offices and Shops Located to Secure Maximum Utilization of Natural Cover

Oblique View from 5,000 Ft Shows Low Visibility of Buildings in Center

TREES SAVED DURING CONSTRUCTION PROVIDE EFFECTIVE SCREEN FOR A BUILDING

duction facilities of the country. Five hundred tons of yellow ochre were recently ordered for the camouflage work in one Engineer District. Although yellow ochre is available from many sources and is not considered critical, this amount was difficult to locate in a hurry.

Since camouflage requirements are so closely interwoven with both the national economy and the military necessities, some central responsibility had to be established. As a result, camouflage measures affecting Government-owned plants operated by the War Department have been made the responsibility of the Chief of Engineers; Navy plants are under the supervision of the Navy Department; and privately owned plants with Government contracts, as well as certain remaining Government plants, are allotted to the Office of Civilian Defense or to either of the two military agencies, depending on the merits of the case. The Office of Civilian Defense is expected to decentralize its camouflage operations under regional directors, and the work of the Corps of Engineers has been delegated to the District and Division offices.

With respect to privately owned plants directly affecting War Department operations, Government participation in the cost has as yet been authorized only in a few specifically designated cases. When this authorization has been granted, the District Engineer may undertake the camouflage designs with his own staff, or he may secure the services of a competent engineering or architectural firm.

"HORSE SENSE" ESSENTIAL

Most of the U.S. Engineer Offices now engaged in camouflage work have a nucleus of personnel who have attended courses on camouflage subjects at Fort Belvoir. In these courses, attention has been given to such subjects as aerial attack procedures, deceptive painting, the use of falsework, interpretation of aerial photography, and the applications of artificial smoke. It has also been possible to demonstrate camouflage technique in the field and to present photographs of extensive camouflage activities in Europe. Considerable attention has been given to the materials and construction problems in camouflage work. Although admittedly such courses could provide only a meager background for the work to be done, in a country prior to the war completely inexperienced in camouflage construction, there was little more that could be done. Also, it is safe to say that aside from a knowledge of a few of the pitfalls and the general method of attacking a problem, the most important qualifications for a camouflage designer are "horse sense" and training in construction methods.

Somewhat like the engineering experimentation of a university, the Engineer Board at Fort Belvoir serves as a development agency for the engineer equipment and materials required by the Army. Since camouflage has long been designated as a responsibility of the Corps of Engineers, development in this field also falls to the lot of the Board. The Camouflage Section of the Engineer Board is a natural outgrowth of this responsibility. This section attempts to translate the information and suggestions received "from overseas and at home," including the results of its own tests, into recommendations for specific action by War Department agencies. To assist in accomplishing this objective, the Section has a considerable group devoting the greater part of its time to assembling information from all available sources and to selecting and editing that information for appropriate distribution. Another group, called the Design Group, has prepared pilot plans for the camouflage of installations and equipment of many kinds, and has attempted to adapt the practices of other countries to our own problems. A third group conducts field tests of both military and industrial types of camouflage materials such as netting, garnishing materials, and structural forms. A laboratory group is concerned with the development of paints and coatings suited to camouflage purposes, and to the analysis of the innumerable commercial products submitted for trial.

The industrial camouflage work of the Engineer Board is coordinated with the camouflage construction work of the District Engineers through the Camouflage Section of the Construction Division, Office of the Chief of Engineers at Washington. In the latter office the technical developments of the Board are reconciled with the needs of the military situation and with the general camouflage program.

EXISTING PLANTS GET CONSIDERATION

By far the greater number of industrial camouflage problems are concerned with existing installations. The development of a proper design naturally begins with an examination of the site. Since we are concerned primarily with attacks from the air, aerial photographs and air observations are indispensable. These are no longer generally available to the public, and to obtain them is likely to require the assistance of federal

CONSTRUCTION OF UTILITY CONNECTIONS NEED NOT REQUIRE DESTRUCTION OF COVER

STEEL WOOL ON WIRE MESH USED TO DISGUISE A ROAD
About 10 or 12 Oz of Steel Wool per Sq Ft Is Required, and Rust-Proofing Is a Problem

authorities. A single vertical view or a mosaic taken from an altitude of 3,000 ft can be enlarged and printed on a transparent film of standard drawing size, to make a most convenient basic tracing.

The aerial photograph will show the plant surrounded by either fields and shrubs, scattered housing or industrial development, or closely crowded city structures. The problem resolves itself into a careful analysis of these adjacent landscape features in order to determine which of them can be most plausibly and economically copied in changing the exterior aspects and masking the identifying features of the plant. Small units can be completely hidden in heavily wooded areas, but larger units, whether in the open or in the trees, may require more elaborate masking, particularly with respect to the heavy shadows. In cities, large buildings can generally be effectively painted or masked to look like smaller ones.

TONING DOWN THOSE COLOR CONTRASTS

Because of the high cost of elaborate disguise, most industries will probably be content with what is now known as simple "toning down." White buildings against dark backgrounds will be darkened. Conspicuously colored water tanks will be painted to blend with the landscape. Informal and native landscape patterns will be allowed to develop in the place of formal and distinguishing designs. Prominent entrances will be suppressed by painting them to resemble simpler ones in the vicinity.

Such measures will not be wasted, if judiciously applied, for the task of the bombardier in sighting and releasing his bomb load is not easy at best. If he is flying 200 miles an hour at 30,000 ft, he is not likely to have much more than 60 sec from the time he first sights his target until he must release the bombs. He will still be $2^1/_2$ miles from the target, horizontally, when the bombs are dropped. Furthermore, in many parts of the country, hazy weather reduces the visibility appreciably during much of the year. Darkness is an additional obstacle to the attacker, and it may be hoped that defending fighter aircraft as well as anti-aircraft artillery will provide some diversion for the bombardier during his critical 60 sec. Although to a limited extent the bombardier may direct his bombs by calculation from closely adjacent landmarks, in general he must see his target in order to hit it.

It is true, of course, that reducing the visibility of the target may not be particularly effective against area bombing. If large numbers of planes drop their bombs in a prearranged design, they have a fair chance of hitting something, even without knowing exactly where it is. For camouflage to be effective against this form of bombing, both the secrecy and the disguise must be sufficiently complete to entirely mislead the enemy as to the area occupied.

WOODS AND STREAMS DIFFICULT TO SIMULATE

The painting of large factory buildings and even of flat surfaces to resemble closely built smaller structures can be accomplished with a surprising degree of success. Streets are painted over roofs, and black strips to resemble shadows are interspersed with lighter patches resembling smaller roofs. Natural terrain features such as dark drainage lines or wooded areas are more difficult to simulate. In large, bold designs, however, such features may have a desirable disruptive effect that aids greatly in obscuring the identity of the structure.

Large, open parking areas are most difficult problems. A desirable solution is complete dispersion of the cars in some adjacent heavily wooded region. Failing this, an arrangement so that their shadows form patterns resembling those of houses or trees may be helpful.

The most elaborate camouflage designs will utilize complete cover or various forms of false construction. Nets of chicken wire or other wire mesh may be stretched to cover streets, alleys, parking areas, low buildings, and saw-tooth roofs. Pipe or wooden frameworks may be used to construct false trees, dummy houses, and many other features of disguise. Lumber, sheet metal, plaster, and various locally available waste products provide expedients for developing the details of more extensive projects. In some instances the planting of trees and shrubs may become an important part of the program. For new construction, too much emphasis cannot be placed on the preservation of existing trees and the restriction of clearing and ground scars to the absolute minimum.

CHIPS AND SHAVINGS REDUCE REFLECTION

There are few subtleties in industrial camouflage design. With the increasing distance of the observer, the colors of the terrain tend to blend into a single hue. Bodies remain distinguishable more by their relative

GROUND AND AERIAL VIEWS OF TWO CAMOUFLAGED TANKS
One Has Received a Disruptive Pattern, the Other a Coat of Olive Drab—Methods Which Will Be More Effective When Ground Cover Has Been Restored

brightness and by the emphasis of shadow than by their color. In order to be effective, designs painted on relatively smooth surfaces must be distinguished by material contrast. Black is used frequently in an effort to imitate the shadows that normally separate different structures. It is almost impossible to imitate the low reflectance of such light-absorbent textures as shrubs and grass with any paint or coating applied to a hard, smooth surface.

As it is frequently desired to match this low reflectance of grass or loose earth by painting over concrete aprons or metal roofs, experiments have been made with various kinds of granular coatings. For traffic surfaces, about the most suitable materials are wood chips obtained as a by-product of lumbering processes from a machine known as a rosser. Such chips are hard enough to retain their form under traffic for a limited time, but are not as abrasive as crushed rock. Whatever the granular material selected, it is applied over bituminous adhesives. It may be pre-colored in a mixer or colored later by spraying. Although such a granulated surface is not likely to equal grass or shrubs in diffuseness of reflection or in light absorption, it will be a considerable improvement over a pavement or a smooth roof.

USE INFRA-RED REFLECTING PAINTS WITH CARE

To meet special camouflage needs, the paint industry has produced a number of useful developments. Lusterless oil paints can now be had for application to wood surfaces. Oleo-resinous emulsions that may be applied with either water or gasoline now supplant the old protein cold-water paints, with many advantages of durability and range of application. Bituminous emulsions, either black or in colors, are the most widely used for traffic surfaces or for other surfaces that have had a previous bituminous coating. Removable, gasoline-soluble paints are available for use in freezing weather. High infra-red reflectance can be had in almost any color paint vehicles, but because of the critical or near-critical value of the pigments, will rarely be justified for an industrial installation except where complete concealment is being undertaken. Unless the shadow of a building is screened, the contrast between the building and its shadow will be intensified in an infra-red photograph rather than minimized by using an infra-red reflecting paint.

In building screens and false walls to cover shadows or disguise structural forms, the lightest kind of materials consistent with reasonable maintenance has been sought. The use of chicken wire with cloth garnishing strips is a heritage from the last war. Both burlap and cotton osnaburg are satisfactory and available for military purposes in moderate quantities. Many substitutes for these are being developed throughout the country. The best texture is one that resembles grass rather than one that is matted and likely to be glossy. Light weight is important, and a coverage of about 60% is usually satisfactory. Fire retardance and weather resistance must be considered. The selection of a stronger wire mesh that will take part of its own dead load may permit a simplification of the supporting framework and rigging.

USE OF STAGE SCENERY TECHNIQUES

Stage scenery techniques have been used to some extent for dummy walls. Wire mesh, supported on wood or pipe frameworks, can be covered with cotton and plaster products, or with any of the garnishing materials. Chicken feathers have been successfully used for this purpose. For chicken-feather garnishing, the wire is passed through a bituminous adhesive and under a hopper of feathers. Rollers then press the feathers into the adhesive, and surplus feathers are blown off. Paint is later applied by spraying.

For large bridges, blast furnaces, high buildings, and densely occupied industrial areas, the smoke screen will probably provide the only concealment available. Generators must be located on all sides of, and throughout, the area to be screened, and the total area must be several times larger than that of the plant, or the screen itself will provide the target. For War Department controlled plants, smoke screens will be operated by the Chemical Warfare Service. In future, as the techniques of smoke generation continue to improve, this method of protection may be expected to have wider application.

With actual camouflage construction in progress in all the critical areas, the next few months will show an important increase in the knowledge of materials and designs. It is a new field for the engineer and one in which he should find a fascinating opportunity to exercise his ingenuity in the application of construction methods.

ROAD BUILT SO AS TO BE PARTIALLY SCREENED BY NATURAL COVER

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Effect of Wind on Hangar Footings by Moment Distribution

By Stanley U. Benscoter, Jun. Am. Soc. C.E.
Assistant Engineer, U.S. Engineer Office, Vicksburg, Miss.

In an attempt to determine base pressures and anchor bolt stresses for hangar footings, I have found the application of moment distribution methods very useful. In the problem here discussed, the reinforcement of the spandrel beam is continuous through the column footing proper so that the spandrel beam and column footing are assumed to act together as a single footing of unusual shape. The footing plan and elevation are shown in Fig. 1.

If the base of the column is considered to be fixed at its joint with the footing, the moment at this joint may be easily computed. There is no knee brace at the top of the column and it is assumed that there is no restraint at this joint. A horizontal deflection of 1 in. was assumed to take place at the top of the column. The fixed-end moment at the bottom of the steel column may be written:

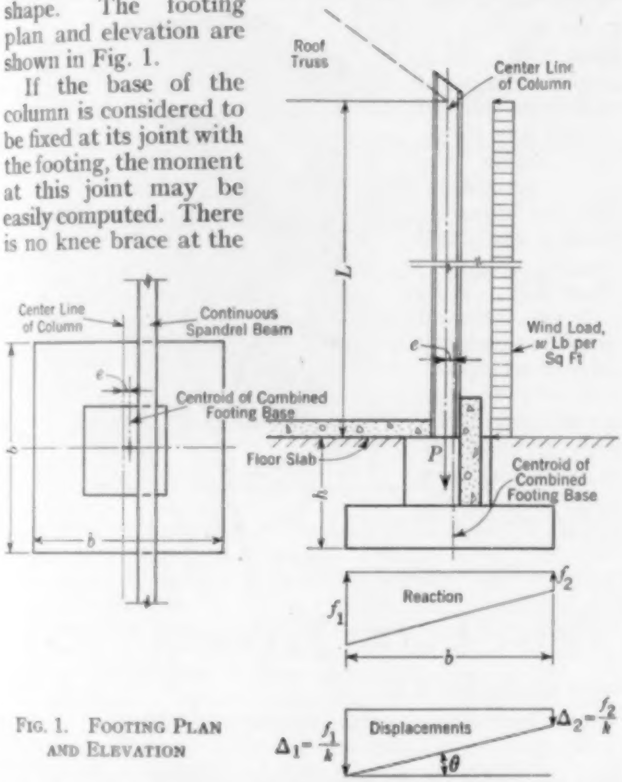


Fig. 1. Footing Plan and Elevation

$$M'_e = -\frac{wL^2}{8} - \frac{3EI}{L^2} \quad (1)$$

The first term gives the effect of a uniform wind load, w, and the second term gives the effect of the unit top displacement. Actually the footing is not fixed but will rotate through an angle θ and we may express the true moment at the joint as

$$M_e = M'_e - S_e\theta \quad (2)$$

where stiffness of the column, S_e, is known and may be written as

$$S_e = \frac{3EI}{L} \quad (3)$$

An equation having the form of Eq. 2 may also be written for the footing:

$$M_f = M'_f - S_f\theta \quad (4)$$

The term M'_f is the joint moment required to prevent rotation of the footing. When θ is zero the base reaction is uniformly distributed and the resultant reaction acts at the centroid of the base area. If the center line of the column is directly over the centroid of the base area, M'_f is zero. In the present case we have

$$M'_f = -eP \quad (5)$$

The stiffness of the footing, S_f, is an interesting concept. It is the change in joint moment which produces a unit rotation of the footing. In order to derive a formula for S_f it is necessary to introduce a foundation modulus k which may be determined from a loading test on a large plate at the site of the structure. Displacements are given by the equation,

$$\Delta = -\frac{f}{k} \quad (6)$$

where f is the unit stress on the soil foundation.

Reaction and displacement diagrams are indicated in Fig. 1. In order to find the stiffness of the footing, consider it separately and assume it to be loaded eccentrically within the kern of the base area. From the displacement diagram we may write,

$$-\theta = \frac{f_1 - f_2}{kb} \quad (7)$$

From the column formula for symmetrical bending,

$$f_1 = \frac{P}{A_f} + \frac{Mc_1}{I_f} \quad (8)$$

$$f_2 = \frac{P}{A_f} - \frac{Mc_2}{I_f} \quad (9)$$

Equation 7 then becomes

$$-\theta = \frac{M(c_1 + c_2)}{kbI_f} = \frac{M}{kI_f} \quad (10)$$

From this equation,

$$M = -kI_f\theta \quad (11)$$

or

$$S_f = kI_f \quad (12)$$

The foundation modulus k was determined by loading a 30-in. diameter plate at the hangar site.

The formulas that have been developed assume no joint translation. In the type of problem illustrated in Fig. 1, translation of the joint is prevented by the floor slab. If we wish to determine the effect of suction on the side wall of the hangar, we must assume a rotation axis

for the footing and remember that the joint is free to translate. If the axis of rotation is assumed to be at a depth h, we can obtain the solution from a single moment distribution procedure by using a modified value of S_c given by

$$S_c = \frac{3EI}{L}\left(1 + \frac{h}{L}\right) \quad \ldots\ldots\ldots\ldots (13)$$

It would be reasonable to assume h as the depth of the footing. A suction force on the example would produce lower values of maximum base pressure and anchor bolt stresses than would result from a wind pressure of equal magnitude.

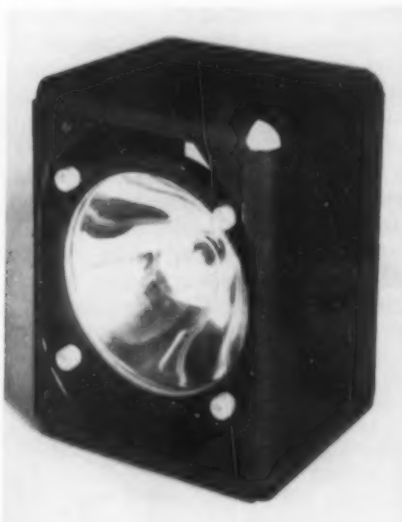
The writer was assisted in the study of this problem by Samuel T. Logan, Jun. Am. Soc. C.E., Junior Engineer, U.S. Engineer Office, Vicksburg, Miss.

Coast and Geodetic Survey Develops New Signal Lamp

By L. O. COLBERT, M. AM. SOC. C.E.

DIRECTOR, U.S. COAST AND GEODETIC SURVEY, WASHINGTON, D.C.

A NEW signal lamp for use in triangulation surveying has been constructed in the instrument laboratory of the U.S. Coast and Geodetic Survey. The new lamp represents an improvement over those previously developed by the Survey in that it is lighter in weight, more compact, and more powerful.



FRONT VIEW OF NEW LAMP

Weighing only $4^3/_4$ lb, the lamp is of all-metal construction. The housing is of spot-welded sheet steel, rigidly braced. "Loss-proof" thumb screws are employed to hold the cover glass in place.

A 5-in. reflector is used where previous types employed 4-in. and 7-in. ones. Tests conducted at the National Bureau of Standards reveal that this reflector, using a 3.7-v, 0.6-amp bulb, develops a maximum beam candlepower of 10,200 at a distance of 95.2 ft. With a 6-v, $1^1/_2$-amp bulb, a beam candlepower of 70,000 was measured under the same condition. Another improvement is the small beam spread—about 2.7°.

It is believed that the new lamp will contribute greatly to the speed and efficiency of night observations over long lines of triangulation.

REAR VIEW OF NEW LAMP

Graphical Solution for Passive Earth Pressure

By PAUL ANDERSEN, ASSOC. M. AM. SOC. C.E.

ASSOCIATE PROFESSOR OF STRUCTURAL ENGINEERING, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

THE active pressure of a cohesionless soil behind a sheet-piling wall can be expressed graphically as the area of a right triangle multiplied by the unit weight of the soil. As will be shown, this determination, generally known as Poncolet's construction, can be extended to include passive pressures in front of walls which, according to Coulomb, can be expressed as

$$P = \frac{w}{2}\left[\frac{h \cos\phi}{1 - \sqrt{\sin\phi\,(\sin\phi - \cos\phi\tan\delta)}}\right]^2 \quad \ldots (1)$$

where w = unit weight of soil
ϕ = angle of internal friction
δ = angle between horizontal and surface

The graphical construction (Fig. 1) is as follows:

Locate the point of intersection, C, between the extension of the front bank surface, AG, and a line through the bottom, B, of the sheet piling, and making an angle with the horizontal equal to the angle of internal friction ϕ. With BC as a diameter, draw a semicircle and intersect it at D with a line from A perpendicular to BC.

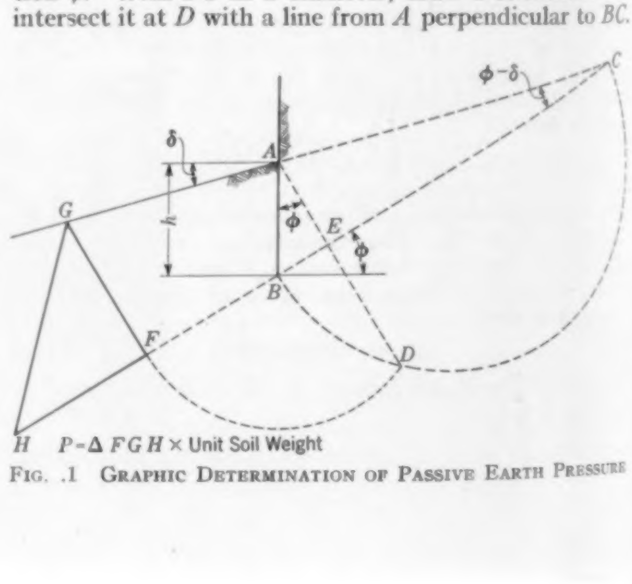


FIG. 1 GRAPHIC DETERMINATION OF PASSIVE EARTH PRESSURE

Make BF equal to BD and erect GF normal to BC. If FH is made equal to FG, then the area of triangle GFH, multiplied by the soil weight, w, will be equal to the passive pressure, P.

The correctness of this construction is verified as follows:

From triangle ABC, $\dfrac{BC}{\sin (90° + \delta)} = \dfrac{h}{\sin (\phi - \delta)}$; or

$$BC = \frac{h}{\sin \phi - \cos \phi \tan \delta} \quad \ldots\ldots\ldots (2)$$

And because BCD is a right triangle,

$$BD = \sqrt{h \sin \phi \, h \frac{\cos \phi}{\sin (\phi - \delta)}} = h \sqrt{\frac{\sin \phi}{\sin \phi - \cos \phi \tan \delta}} \quad \ldots\ldots\ldots (3)$$

The distance between F and C can be expressed as the sum of FB and BC, that is, as the sum of BD (Eq. 3) and BC (Eq. 2). Thus

$$FC = \frac{h}{\sin \phi - \cos \phi \tan \delta} + \frac{h \sqrt{\sin \phi}}{\sqrt{\sin \phi - \cos \phi \tan \delta}} = h \frac{1 + \sqrt{\sin \phi \, (\sin \phi - \cos \phi \tan \delta)}}{\sin \phi - \cos \phi \tan \delta} \quad \ldots\ldots (4)$$

But $FG = FC \tan (\phi - \delta)$, from which

$$FG = h \frac{1 + \sqrt{\sin \phi \, (\sin \phi - \cos \phi \tan \delta)}}{\cos \phi + \sin \phi \tan \delta} \quad \ldots (5)$$

If numerator and denominator in Eq. 5 are multiplied by $1 - \sqrt{\sin \phi \, (\sin \phi - \cos \phi \tan \delta)}$, this expression becomes

$$FG = \frac{h \cos \phi}{1 - \sqrt{\sin \phi \, (\sin \phi - \cos \phi \tan \delta)}} \quad \ldots (6)$$

which is the term appearing between brackets in Eq. 1.

Hence, $P = \dfrac{w}{2} (FG \times FG) = \dfrac{w}{2} \times (FG \times FH) = w \times$ area $\Delta\, GFH$.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Closure of Discussion on Engineers and World Economy

To the Editor: The writer regrets that it is not possible to give a detailed reply to each of the discussers of his article, "Engineers and World Economy," in the December 1941 issue of Civil Engineering. It is again evident from the discussions that the real difficulty in the way of solving the economic problem is the very simplicity of the problem itself. Apparently the most difficult thing in the world to achieve is a fundamental change in point of view. It is tragic to reflect at this time of world horrors that such a change might have prevented two wars and a major depression. From high sources in the governments of the United Nations comes the assurance, however, that the simplicity of the problem is at last being realized. Recent speeches of such men as Vice-President Harry A. Wallace, Thurman Arnold, Sumner Welles, and of others both in the United States and in the allied countries clearly show this trend. All the catastrophes referred to will have been worth while if they result in an understanding of the fundamentals prerequisite to the establishment of permanent peace and prosperity for all the peoples of the earth.

The objections of most of the discussers of my article arise from lack of understanding of the very simplicity of the problem. These authors are confusing two entirely different things—fundamental policy making with technical details. It is precisely because of his training in the physical sciences that the engineer is peculiarly fitted to take a leading part in the policy-making phase of the solution. The engineer and the scientist know that two pairs of shoes are better than one pair, that two apples are better than one, that waste is a social crime. The engineer's training enables him to know that any reasoning which leads to the conclusion that scarcity is beneficial is wrong, criminally wrong. We had to enter a second World War because these fundamentals were not understood. However, Sir Norman Angell pointed out these facts in 1908 in his book, *The Great Illusion*. It was the same writer who also said that "the broad, general principles and the guiding facts of any science are simple; it is only the details that are complex and confusing."

Such bookkeeping conceptions as national debts, purchasing power, and the financial system itself are details to be worked out by the "experts"—after the fundamental policies are determined by "amateurs" possessed of sufficient common sense to know that the purpose of an economic system is not something called "good business" but to provide all peoples with the necessities of life. Dean Sullivan and Mr. Kosh make the error already referred to, that of confusing fundamental policy making with technical details. This fact accounts for their misunderstanding of the kind of surveys mentioned in my article and confusing these with the economists' surveys based on probable purchasing power superimposed on such man-made nonsense as business cycles. Such reasoning leads to the erroneous conclusion that a poverty-stricken world is suffering from overproduction.

Events since December 7th prove my statement that it is only after we are led into committing the supreme insanity of going to war that we manage to run our economy on a sane basis—of "needs" against "ability to produce." Apparently when all-out production is the goal, business cycles go out the window—forever, it is to be hoped—along with other fetishes of the "experts." It is for the amateur to decide that the war effort must be turned into a peace effort after the cessation of hostilities, and it is for the expert to determine the bookkeeping details of this effort.

The basis of the realistic point of view necessary to a solution of the economic problem is the ability to think in terms of fundamental realities—tons, cubic yards, number of pieces—and to keep always in mind the purpose of any economic system. It is we, the engineers and the scientists, who are the experts on this policy-making phase of the problem, and it is the others who are the amateurs. We must ensure that the winning of the war shall not be merely another armistice to be broken by a bigger and more devastating third world war. The leaders of the democracies have given orthodoxy to this point of view, and it is time that the leaders of the professions take their place in the policy-making councils of the world. Such an opportunity for service may never come again.

Bernard L. Weiner, M. Am. Soc. C.E.
With Christiani and Nielsen Corporation
New York, N.Y.

Correction in Equation

To the Editor: In my article, "The Importance of Considering Side-Wall Friction in Bed-Load Investigations," appearing in the June issue, two corrections may well be called to the attention of readers. In Eq. 7 the Reynolds number is based on the pipe diameter instead of the pipe radius. Thus, since the value of the pipe diameter is four times the hydraulic radius of the pipe, the numerical term in Eq. 8 should be 4 instead of 2.

In Fig. 2, the term "grams" was intended instead of "grains," as stated.

Joe W. Johnson, Assoc. M. Am. Soc. C.E.
Hydraulic Engineer, U.S. Soil Conservation Service
Washington, D.C.

Land Marks of Surveying—II

Consideration of the letter and photograph under the heading, "The First P. I.," on page 398 of the July issue, impels one of our anonymous correspondents to send in an example of a second

UNUSUAL FORESIGHT

surveying feat. The accompanying illustration suggests to him an appropriate doggerel:

The engineer with his over-worked mind
So often develops a brow full of furrows,
His burdens are lightened, we now seem to find,
As part of his job's taken over by burros.

Engineers' hands are so full these days, he suggests, they may well consider this adoption of ear, instead of hand signalling.

Simplifying Earthwork Calculations

DEAR SIR: At the end of the article by F. F. Fergusson on "Earthwork Calculations Simplified," in the June issue of CIVIL ENGINEERING, an editorial note calls attention to two previous references to similar methods.

Another presentation of that method in which readers of CIVIL ENGINEERING may be interested occurrs in a volume entitled *Route Surveying* by Professors Pickels and Wiley, of the University of Illinois. This work (published by John Wiley and Sons in 1930) uses the method in question for calculating areas of cross sections, including side-hill and uncompleted sections.

WILLIAM MUNSE

Chicago, Ill.

New Procedure for Meteorological Analysis

TO THE EDITOR: The article by G. E. Larson on "Research for Flood Control Data," in the March issue, is especially pertinent at this time when a large portion of the Weather Bureau's staff is involved in aerological and climatological research for the Armed Services and allied war effort.

His very complete survey of the field of hydrologic data was particularly interesting to the Hydrometeorological Section which is cooperating with the Corps of Engineers in estimating maximum storm rainfall. Although the research on storms done by this Section is primarily concerned with major storms over selected basins, we have had occasion to use nearly all the various sources and procedures outlined. Each particular storm study is compiled by thorough research of all field sources of data and later supplemented by additional search of data on file only at the National Archives and the Congressional Library. This research work provided a basis for the compilation of a complete file of meteorological references which expedites systematic research on individual storms. A source of data which has been found to be most helpful and should be included in hydrologic research literature is the record kept by various commercial interests such as utilities, railroads, milling companies, and so on. These data are usually unpublished and therefore frequently overlooked.

A new procedure in mass meteorological analysis was established while we were engaged in the study of the Ohio River Basin above Pittsburgh. It is necessary in each basin study to determine the critical storm patterns and precipitation characteristics for the region of meteorological homogeneity embracing the basin, which can only be done by study of the synoptic charts covering each critical storm sequence. Since over 265 storms were involved in the Ohio River Basin study, transcription and plotting of the data alone would have become a major problem. The analyses of this large amount of meteorological material were accomplished by microfilming the synoptic charts for each storm period and analyzing the projections, thereby not only reducing the involved time, personnel, and materials to a minimum, but also permitting the presentation of the synoptic charts in cineographic effect as an aid in analysis. The slight expense involved was more than compensated by avoiding the impairment of irreplaceable original manuscript charts and the convenience of not having to handle a large amount of cumbersome material.

A. K. SHOWALTER
Meteorologist in Charge,
Hydrometeorological Section,
U.S. Weather Bureau

Washington, D.C.

Engineers and Architects Must Cooperate

TO THE EDITOR: In the July issue John Girand, Assoc. M. Am. Soc. C.E., raises a controversy that belongs to the days of trousers with cuffs when he asserts that the Phoenix low-cost housing development was the work of engineers rather than of architects.

His remark that the low-cost housing problem has been solved primarily by engineers is questionable. As far as the writer has been able to judge, whatever improvements we have in low-cost housing have been the work of administrators, sociologists, and architects, as well as of engineers. Low-cost housing is a complex enterprise that requires many skills, and it is a matter of conjecture as to which skill has contributed most to the solution of low-cost housing.

The architect is almost completely disregarded by Mr. Girand, who seems to forget that the man who plans buildings is thereby an architect, even though he may call himself an engineer. Sir Christopher Wren was an architect by virtue of the churches he built, although by previous experience he was a mathematician and Savilian professor of astronomy at Oxford. When Thomas Jefferson, author of the Declaration of Independence, designed the buildings at the University of Virginia, he became Thomas Jefferson, architect. Those who planned the Phoenix houses were architects. Analogously, chemists or biologists who do sanitary engineering work are sanitary engineers, as the Society's Committee on the Advancement of Sanitary Engineering points out in the June 1942 issue of PROCEEDINGS. It may be true that many architects are unable to carry out work of the scope described by Mr. Girand and that their place is being taken by men trained as engineers, but all that this can mean is that the architect has been inadequately trained for his job or that the job has become too difficult for one man to handle.

It may be that Mr. Girand's distinction between architect and engineer is arbitrary after all. He speaks of the site planner as an engineer and of the truss designer as an engineer. Either one could as easily be called an architect. It is a historical fact that one of the greatest city planners of antiquity—the man who planned the harbor town of Peiraeus at Athens and who laid out the city of Rhodes—was an architect, Hippodamus of Miletus, a contemporary of Pericles. The men who built the vaults and buttresses of medieval cathedrals have come down to us as architects. The great dome of the Cathedral of Florence was conceived by the architect Brunelleschi in the fifteenth century. It might be claimed that these men were engineers, but exactly what purpose would be served by calling them engineers instead of architects when common usage accepts them as architects?

Actually, the architect has much more in common with the structural engineer than the structural engineer has in common with the hydraulic engineer. However, because of certain past historical associations, both the structural and hydraulic specialists are called engineers, whereas the architect is not. This is because the architect has often been identified with the artist as distinct from the technician. Art, however, is only one part of the architect's work. On the technical side, the architect deals with the science of structures. The Society's acceptance of architects to membership implies a recognition of this side of the architect's activity. If the architect is unable to design foundations of difficult character or to plan the ventilating system for a skyscraper, it is because these fields have become increasingly complex with the development of modern science and technology. It should not be considered a criticism of the architect's competence to consult an authority on soil mechanics any more than it should be considered a failing of the hydrologist to yield to the opinions of the electrical engineer in questions involving electrical layout. In this age of specialization we ought to realize that large building tasks are solved by group effort. It is a form of professional short-sightedness not to do so, particularly when it discredits the efforts of fellow professionals.

M. F. KIRCHMAN, Assoc. M. Am. Soc. C.E.

Brooklyn, N.Y.

Comments on Earthwork Calculations

DEAR SIR: The method of calculating earthwork, explained by F. F. Fergusson in the June issue, is outlined by Prof. G. W. Pickels in the first edition of *Drainage and Flood Control Engineering* (page 192). This method of calculating end areas is used by the U.S. Corps of Engineers. However, it should be even more widely used than it is, since it is a uniform method (that is, each cross section does not become a special case) and accurate results can be obtained more quickly than by any other method. Mr. Fergusson places his base line in the center of the area, thereby creating some confusion by using both positive and negative signs. Such confusion can be avoided by keeping the base line always outside the area or by dividing the area into two distinct calculations.

The best feature of this method of area calculation is that it lends itself admirably to the use of a calculating machine. Multiplications are made along the solid lines and products are accumulated. Then without clearing the product dial the machine is thrown into reverse and reverse multiplied along the dotted lines. When the end is reached the remainder is divided by two, giving the correct answer.

BENJAMIN C. SEAL, Assoc. M. Am. Soc. C.E.
Captain, Corps of Engineers
Victory Ordnance Plant Project

Decatur, Ill.

The Simplification of Earthwork Calculations

TO THE EDITOR: In connection with the article, "Earthwork Calculations Simplified" by F. F. Fergusson, in the June issue, I would like to point out that American railroad engineers have long used and referred to this identical device.

As a matter of fact, the method has been published by J. C. Nagle in *Field Manual for Railroad Engineers* (2 ed. re.i-ed, 1906, pp. 189 and 190). Quoting from this source, "Suppose there have been n levels taken on one side exclusive of the center height, the notes would appear as below:

$$\frac{h_0}{0}\ \frac{h_1}{d_1}\ \frac{h_2}{d_2} \cdots \frac{h_{n-1}}{d_{n-1}}\ \frac{h_n}{d_n}\ \frac{0}{b}.$$ Expanded, the area to right =

$$A_R = {}^1/_2[(h_0d_1 + h_1d_2 + \ldots h_{n-1}d_n + h_nb) - (d_1h_2 + \ldots d_{n-1}h_n)]"$$

Evidently n may have any positive integral value. Articles such as Mr. Fergusson's are helpful in bringing to light sources of information that might otherwise be overlooked.

VIRGIL A. EBERLY, Assoc. M. Am. Soc. C.E.
Designing Engineer of Bridges and Grade Separations, Ohio State Highway Department

Columbus, Ohio

Tremie Concrete Long in Use

TO THE EDITOR: The article by Admiral Harris on the use of "tremie" concrete in dry-dock construction, in the June issue, led me to reexamine some of my notes on the history of this method of placing under-water concrete.

According to Murray's dictionary, the first usage of the word tremie was in 1905. As a matter of fact, however, both the method and the word are much older. The earliest application of the method that has come to my attention was in the building of the foundations of Fort Carroll on Chesapeake Bay which, according to contemporary reports of the U.S. Army, was "under construction" in 1851.

The earliest usage of the word that I have encountered is in Q. A. Gillmore's *Practical Treatise on Limes, Hydraulic Cements, and Mortars*—written in 1861 and published in 1863—in which he described the work at Fort Carroll. It is interesting to note that Gillmore also described the construction of Graving Dock No. 3 at Toulon, where a foundation 100 by 400 ft and 15 ft thick was laid in one mass. The exact method of placing this under-water concrete was not stated.

A description of the tremie method also appeared in I. O. Baker's *Treatise on Masonry Construction*, published in 1889. The books of Gillmore and Baker were the best known and most authoritative on this subject during the 42-year period preceding 1905 when the first of the more modern books on concrete appeared. The above usages antedate Murray's earliest reference by 42 and 16 years.

The technique of handling the tremie has been somewhat modified and improved, but the essential features of the method are the same today as they were nearly a century ago at Fort Carroll.

DUFF A. ABRAMS, M. AM. SOC. C.E.
Consulting Engineer

New York, N.Y.

Device for Measuring Static Heads

DEAR SIR: The "Crest-Stage Meter for Measuring Static Heads," described by Mr. Collet in the July issue, is a very interesting and, no doubt, practical device. The basic idea, however, is not new.

Here (Fig. 1) is a sketch of a simple device that I developed some fifteen years ago to perform the same function as Mr. Collet's crest-stage meter. It was designed originally to be used in irrigation canals, but it is just as useful in natural streams.

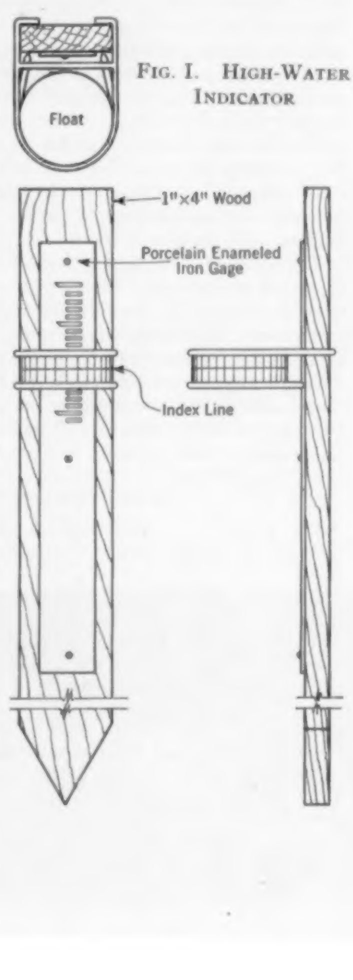


FIG. 1. HIGH-WATER INDICATOR

There appears to be very little demand for such a device, since modern hydrographic work demands complete graphic records—the maximum is not enough. The maximum during a flood peak is of course desirable, but that maximum at only one point in a stream is not sufficient. Flood marks left by the water are continuous and may be found shortly after the flood has passed. Another point is that maximum gages as well as flood marks reflect the wave or surge summits—another reason for graphic records.

J. C. STEVENS, M. Am. Soc. C.E.
Consulting Engineer

Portland, Ore.

SOCIETY AFFAIRS

Official and Semi-Official

Wartime Convention in Minneapolis

Well-Arranged Program Appeals to All Those Present at Society's Midwest Gathering

Overcoming the difficulties of overburdened air and rail transportation, or taking a few more miles from those carefully preserved tires, over 300 members and friends convened on the large University of Minnesota campus for the Society's Summer Convention, to discuss further services engineers can give to their country. For the three official Convention days, July 21 to 23, and several other days of important committee meetings, Minneapolis and the Northwestern Section acted as hosts to the Society.

In the strikingly appointed main ballroom of the Coffman Memorial Union, the opening session and the entire Convention were dedicated by the singing of "America." Then followed the formalities whereby the meeting got officially under way.

Immediately the guests felt themselves at home. President Coffey of the University welcomed the Convention to the campus. Then Mayor Kline, himself an engineer, reiterated this expression of hospitality. The City of Minneapolis must be engineer minded, for in addition the president of the Council and three other members are engineers. A third welcome came from President Priester of the Engineers Club of Minneapolis, who recalled its formation forty-nine years previously, one particular purpose being to help entertain the Society in June.

War Problems to the Fore

In his annual Address, President E. B. Black reviewed the current activities of the Society. He showed how its efforts were devoted to promotion of national and professional welfare in both peace and war. Dean Stevenson, of the University's School of Business Administration, followed with a penetrating analysis of "Economics in War Efforts." In this he advocated a number of original approaches in dealing economically with all-out activities, not only during the war but in planning for the post-war period.

At the Wednesday men's luncheon, Ralph Budd, M. Am. Soc. C.E., discussed the all-important role of transportation in the prosecution of the war. Opportunity was provided at this noontime affair for meeting old friends and making new acquaintances. The membership divided in the afternoon for two most important symposiums. The Hydraulics Division repaired to the St. Anthony's Falls Hydraulic Laboratory a mile away for a discussion of wartime water supply problems, while the session prepared by the Society's National Committee on Civilian Protection in Wartime convened at the Coffman Memorial Union. A number of striking demonstrations of the developing science of civilian protection were presented.

The fine plant of the Hydraulics Laboratory was on exhibition following the technical meeting held there. Many of its activities were displayed—by models, by apparatus, and by tests of actual equipment. Some of the exhibits were of percolation through earth dams, problems of flow in inclined channels using a tilting flume, energy control through the hydraulic jump, safety of sanitary house fixtures, hydraulics of highway culverts, and finally a huge model of the area at and below St. Andrews Falls, site of the Laboratory itself, showing proposed locks and river control.

Local Sections Conference

For a full day preceding the Annual Convention, the Local Sections Conference met to discuss the Society's contribution to the war effort and to consider means of improving professional efficiency through a solution of the problem of employer-employee relations. Representatives of Local Sections from the Western and Mid-Western areas were joined by interested officers and members in these important discussions.

At the Northwestern Section dinner on Tuesday evening, the assembly of members and ladies was addressed by Prof. Harold Deutsch of the University of Minnesota on "Russia and the War." The capable staff of the Union's dining rooms served an excellent and carefully planned dinner.

At Engineers' Luncheon on Tuesday
Left to Right, Col. Wm. N. Carey, George J. Schroepfer, and E. B. Black, President of the Society

Following the precedent of the Spring Meeting, formaldress was dispensed with at all functions with the exception of the Wednesday dinner and social evening. Hotel Nicollet, downtown headquarters, prepared its grand ballroom for the splendid dinner and entertainment. Dr. Walter Judd of Minneapolis told of his opportunity for observing the "Roots of Conflict in the Pacific." His stirring address was supplemented by a humorous dialect number and by some excellent selections by a quartet of professional men, two of whom were engineers.

Bright and early on Thursday, engineers gathered at the Union for a day of technical discussion. The Sanitary Engineering Division reviewed the preparedness of civilian and military sewerage systems. That the greatest volume of construction ever reached has called for the utmost cooperation between American engineers and contractors, was shown in the symposium presented by the Construction Division on the engineering features of war construction. As many as possible of the papers presented at the technical sessions will be published in Civil Engineering and Proceedings.

Exhibits Supplement Engineering Sessions

The technical meetings were divided into two parts by the luncheon at the Union. Major Lynn Barnes addressed the group. His subject was "The Use of Critical Materials in Wartime." In the afternoon the City Planning Division probed the effect of wartime dislocation of population on long-range planning, while the Structural Division investigated the subject of substitutions that can be made for critical construction materials.

Group Attending Local Sections Conference, July 21, Outside Coffman Memorial Union

One section of the Union building was given over to exhibits of interest to civil engineers. A good variety of subject matter illustrated the activities of many public engineering organizations. The University was represented by a photo-elastic demonstration, the State Highway Department exemplified its work by models, photographic exhibits, and maintenance apparatus; the WPA showed work in planning around Minneapolis; the St. Paul City Planning Board used maps, perspective drawings, models, relief maps, and reports to indicate its activities; the State Department of Conservation displayed colored photographs of hydraulic structures; and both the Minneapolis-St. Paul Sanitary District and the St. Paul Water Department illustrated some interesting solutions of their important problems. Entirely free from commercial aspects, this whole exhibit proved instructive to many visitors throughout the three days of meetings in the Union.

Ladies Delightfully Entertained

Members who were fortunate enough to be accompanied by their ladies had an opportunity to be with them at several of the functions. In addition to the dinners of Tuesday and Wednesday evenings, groups assembled to enjoy the festivities of the Aquatennial on Thursday evening.

The desire to refrain from adding to the load on transportation facilities restricted inspection trips. However, the ladies were royally entertained with teas, shopping trips, and luncheons. In addition, some found time for brief local trips. All thoroughly enjoyed the pleasant contacts with old and new friends which the meeting afforded.

Those visitors who wished could take in the events of the Minneapolis Aquatennial, an annual civic festival extending over the week of the Society's meeting. The celebration started in earnest on the previous Saturday, highlighted by a mammoth parade featuring floats, bands, and marchers. As the first engineers were arriving for the meeting, they found this activity in full swing. From then on, including Sunday, there was a continuous round of athletic events, musical festivals, horse shows, regattas, and other events. A Paul Bunyan Canoe Derby, extending over more than a week, finished during the period.

Officers and committees of the Northwestern Section of the Society did an unusually good job of attending to their various duties. As a result the many details were conducted efficiently and without a hitch. In part this was also due to the remarkable facilities of the Coffman Memorial Union at the University, where almost all the events took place. This is one of the larger and finer social buildings in American universities—in some respects, many visitors felt, the finest. The appointments were more than ample and the decorations superb. Utility and beauty were thus combined to afford facilities ideal for a Society meeting.

The Minnesota Federation of Architectural and Engineering Societies formally interested itself in the meeting. Its July *Bulletin* was devoted exclusively to the Society Convention. Articles, personal sketches, and the full technical and social program, all gave good publicity for the meeting. Even the advertisements reflected the good will of local business men and organizations.

Those who were able to attend were joined in spirit by countless other members, whose responsibilities kept them at work, in a renewed understanding of the endless tasks and consuming duties awaiting our profession in the trying months ahead.

Technical Advice Is Not Free

The aftermath of an interesting engineering problem presented to the Cleveland Section, and noted in the June "Society Affairs," is now made known. It will be recalled that the Section was asked by officials of the City of Cleveland to present names of those who could give somewhat extensive and valuable engineering services to the city without compensation. The Section tactfully suggested that the proper type of men be employed on a consulting basis, and offered its advice regarding desirable choices.

Fortunately the city saw fit to follow this procedure, and in due course it selected three men to review and report on the disposition of its Central Viaduct over the Cuyahoga River. The group chosen is composed of Burton R. Leffler, Wendell P. Brown, and William J. Carter, all members of the Society.

The important point to note is that these men are being employed on a consulting basis.

Scrap and the Civil Engineer

Civil engineers have had, now have, and will continue to have a most important role in this war. A few months ago they were called upon for all kinds of rush design and construction—work that was wanted "yesterday"—docks, harbors, cantonments, roads, utilities, new buildings for war production, air bases, naval bases, Army bases—an almost endless list.

Now they are called upon again, and this time it is not the civil engineering profession alone, but every man, woman, and child in the United States that must heed the call. This is in connection with a very special service—the salvage of scrap. This effort is part of a huge national program, sponsored by the Bureau of Industrial Conservation of the War Production Board.

Ways the Engineer Can Help

Regardless of what type of work a civil engineer is engaged in, he can do his part. A number of ways immediately suggest themselves. They are noted here both as a reminder and as a sort of check list.

Are you a contractor? In your yards there are undoubtedly all kinds of obsolete equipment—items you have been "saving," but which actually are of no further use to you. Take a look around. Do it yourself, don't delegate the job to someone afraid to make decisions as to what should go. Get a crew organized and start piling up your "junk." Then call the nearest salvage depot—they'll send for it. Get at it now!

Are you in the utility field? Water works? How about those old broken pieces of pipe—cracked fittings—old hydrant barrels? Look over the plant. Do you honestly think that old pump will ever be operated again?. . . . Electric? Certainly you sell your scrap copper. But sell it now! It is needed today! What about those old motors beyond repair. And that old generating plant equipment which will never be used again? Yes, it will cost money to tear it out, but remember that the war is not free. And this scrap is needed for the war.

All Must Cooperate

Are you a consulting engineer? You haven't any scrap to speak of in your office, but you do have clients. In all probability you have already been advising them respecting the use of substitute materials, or conservative use of critical materials. Discuss with them now the importance of locating scrap. You may be familiar with their equipment and plant. Suggest to them what they could dispose of, and tell them there is no time to be lost.

Are you in the railroad field? You are rendering a very vital service—transportation. But there is more you can do! Get rid of your scrap. What scrap? You've already "cleaned house?" Not every one has. There's a railroad in a Southern state which abandoned the use of block signals several years ago—yet the old signal columns are still standing idle along the track. In New England there are several miles of track in an old line long since out of operation. You railroad men must know of many other similar cases. The Japs are turning every pound of scrap they can lay their hands on into war equipment. What about us?

Are you in highway work? A few years ago some one in your field had the brilliant idea of making long-life sign posts out of road scraper blades. Go back to the wooden posts for a while and let's have those old blades, and old road equipment of any kind. There must be plenty of it, and when will it ever serve its country better than now?

Are you in a municipal department? The city "yard" is nearly always a "museum" where everything has been stored "ever since"—old equipment, old tools, and a thousand and one relics of days gone by. Clean house before it is cleaned for you by someone whose language you won't understand. This is the time for "house cleaning."

Are You a Loyal American? No matter what field of engineering you are in, there is some way to help in this scrap salvage job which must be done. Maybe the task starts at home. This is not a job for the "other fellow"! As civil engineers you know how urgent is the need for scrap material. Engineers have that certain ingenuity and initiative required for any job. Figure out how best your efforts can be expended—then act!

YOUR COUNTRY NEEDS SCRAP!

Maj. Walter E. Jessup Now in Corps of Engineers

DEMANDS FOR WAR service again took their toll from the Headquarters staff of the Society when Walter E. Jessup was inducted as a major in the Engineer Corps on July 9. The fourth engineer taken from the Society's staff, he joins the following in war service: Carl E. Beam, M. Am. Soc. C.E., Commander, CEC, U.S.N.R.; Allen P. Richmond, Jr., M. Am. Soc. C.E., Lieutenant-Colonel, Field Artillery, U.S.A.; and Donald P. Barnes, Assoc. M. Am. Soc. C.E., Major, Corps of Engineers, U.S.A. Mention should also be made of Don Johnstone, Assoc. M. Am. Soc. C.E., now Lieutenant, CEC, U.S.N.R., who was a member of the editorial staff shortly before he went into naval service. As far as the Society is concerned, all these losses are serious and create difficult periods of readjustment.

MAJ. WALTER E. JESSUP

Major Jessup has given significant service to the Society in at least four different phases of its work. He was the editor of CIVIL ENGINEERING from 1930 to 1935, Field Secretary of the Society until 1940, then Washington representative for a year, and recently acting assistant secretary succeeding Commander Beam. In the first three positions he was also the first incumbent, and in all he has made a worthwhile contribution to Society progress.

To commemorate these happy associations, a number of his friends on the staff, both men and women, together with one former member of the Board, joined in a farewell lunch on Wednesday, July 8. As tokens of appreciation they presented him with a wrist watch suitably engraved, and a written message of greeting and good luck.

Beyond his confreres of the staff, Mr. Jessup will be sincerely missed in Society work, for his ability, his personality, and his character. With him he takes the best wishes of all.

Man Power Mobilization Board

THE TURBULENT world conditions with which Government, industry, labor, and the professions are at present confronted are such that material readjustment in working conditions may be expected. In some regards, the civil engineer is more susceptible to the effects of such readjustment than other professional fields.

The Man Power Mobilization Board, recently established under the direction of the Hon. Paul V. McNutt, is charged with the difficult problem of mobilizing and utilizing American man power in the most efficient manner. It is not possible to forecast the course such mobilization and utilization of man power will follow. One of the apparent certainties is that the mobilization program will utilize the widespread organization of the U.S. Employment Service, an agency created during the depression years, but now being streamlined and adapted to the job of working closely with the Man Power Board in the present war effort.

In order that civil engineers may be located quickly, it is suggested that any engineer anticipating a change in employment status, should register at once with his local U.S. Employment office. This procedure will make the names of all available civil engineers immediately accessible to the Man Power Mobilization Board, and such a registration will facilitate their findings and place the badly needed civil engineers in a position to render service in the war effort.

It is impractical to predict when the peak of civil engineering employment may be reached but it is likely that a lessening in employment will occur in the not too distant future.

Civil engineers should also be sure that their professional records are on file in the office of the National Roster of Scientific and Technical Personnel, in Washington, D.C.

Georgia Section Stresses Sociability for Summer Program

MANY SECTIONS have the problem of maintaining summer interests in the Society and the profession. And like many others, the Georgia Section discussed the advisability of omitting any program until fall. Instead, the best judgment indicated that meetings should continue to be held regularly regardless of a possible small attendance, with the thought that interest might be lost entirely in case of discontinuance.

One way this plan has worked out is indicated in the recent issue of the *Georgia Section News*, which carries the following announcement for a luncheon meeting on July 13:

"Speaker: Nobody.
"Subject: Nothing.

"A truly hot-weather program is planned. Light lunch, light conversation, light stories. Guys with grouches can check them in the lobby. Captains of industry can check their coats there too."

It is highly probable that other Sections could well afford to continue summer meetings, even if for no other reason than just sociability.

More Illustrated Lectures Available

IN THE July issue appeared a list of six new illustrated lectures recently added to those available from Headquarters for the use of Student Chapters. Now acceptances from four more authors have been received, adding still further to the list of available lectures. The added lectures, with their authors, are as follows:

Walter D. Binger, Commissioner of Borough Works, Borough of Manhattan, New York, N.Y.	"Construction of East River Drive"
Loran D. Gayton, Assistant City Engineer, Chicago, Ill.	"History and Development of Chicago Water Supply"
Julian Hinds, General Manager and Chief Engineer, Metropolitan Water District of Southern California, Los Angeles, Calif.	"Colorado River Aqueduct"
Francis T. Crowe, General Superintendent, Pacific Constructors, Shasta Dam, Calif.	"Construction of Shasta Dam"

All the lectures in the set, totaling 35 up to the present time, are sent on request, prepaid, for the use of Student Chapters in connection with their meetings. Requests should reach Headquarters as far in advance of a meeting as possible so as to insure that the particular lecture desired will be available.

Philadelphia Section Helps in Promoting Water Conservation

SOME MEMBERS of the Philadelphia Section have been rendering a public service in connection with the local water conservation campaign. In part this has been carried on through radio broadcasts. One such talk was delivered by Charles A. Howland, Assoc. M. Am. Soc. C.E., president of the Philadelphia Section, under the title, "Water Conservation and the Civil Engineer." To illustrate his approach to this important topic and as a possible aid to other engineers who may have similar opportunities, a few of his points are quoted herewith:

"All of us on the home front in this war have a real part and a real responsibility in the task of keeping supplies moving to our fighters on the battle fronts. An important duty is to make certain that enough water, an absolute necessity for the making of supplies, is furnished to the industries which make the supplies. . . . This means that no water must be wasted.

"Those who have the job of pumping, filtering, and delivering the water required for a multitude of public and private uses must have the cooperation of those to whom the water is delivered. Neither those who deliver the water nor those who receive it,

working alone, can make sure that the water supply systems will meet the wartime needs.

"As a civil engineer, and as president of the Philadelphia Section, . . . I look at the situation from the viewpoint of those who have the job of obtaining water, making it fit to use, and delivering it to the consumers. Many of those on whom this responsibility rests are civil engineers. Their task is not a simple one.

"A long way back of your water faucet is the source from which the water comes. The sources of the principal water supplies in the Philadelphia district are surface streams. There is plenty of water in the streams, but the water is not fit for human consumption. It is dirty and carries the bacteria of disease. The water must be cleaned and the harmful bacteria removed or destroyed.

"Filters of graded sand and gravel—many acres of them—are required to clean the water pumped from the rivers. Proportionately small quantities of substances—alum is a principal one—are added at some of the filters to aid in filtration. In removing the dirt from the water, the filters themselves become dirty, and must be cleaned. You can see that to design and build such structures so that the water will flow to and from the filters easily; so that the filters will be big enough, but not too big; so that they will contain just enough sand and gravel of the right sizes; so that they will be properly equipped for adding alum or other substances in the correct amounts; and finally, so that they will be equipped for cleaning, requires considerable engineering study and skill. Moreover, the filters must be operated so that they will go on doing their job day after day.

"Filtration, however, is not enough. We start with a very dirty water, and although 99% of the bacteria are removed by the filters, some bacteria get by. Therefore, before the water is safe to use, chlorine is added to destroy the remaining bacteria. Only a small dose of chlorine is necessary—it averages considerably less than one pound in a million pounds of water—but sometimes it gives the water an odor. The odor does not mean that the water is harmful; it is an odor of safety. . . . In order to reach all sections of the city, a large part of the water must be pumped again; some of it is pumped a third and fourth time.

"Surely a product which has required so much care to prepare and deliver to you should not be wasted. Of course, water does not cost much compared with coal, gasoline, sugar, and such things—at meter rates you pay less than a nickel a ton for water in Philadelphia—but that is not the point. Enough water must be available for war industries; if you waste it, there will not be enough. Moreover, should some emergency arise, such as an extensive fire from an ordinary cause, or many fires from an enemy bombing attack, there may not be enough water to fight the fires. The pumps, filter plants, and distribution pipes which I have described, are limited in capacity, and cannot be enlarged quickly even if the materials could be obtained. We must do the job with the equipment at hand.

"That is why you are asked to stop leaks in your plumbing as soon as you can discover them. One leak will not stop the war effort, but thousands of them may slow down production. . . . Also, you can help by not taking more water than you need. For example, don't let the water run continuously when you are shaving or washing the dishes. Don't let the lawn sprinkler run longer than is absolutely necessary.

"Now, you may be thinking, 'This is all very well. We consumers will cooperate with you fellows who are delivering the water. We'll do our part. But how about the leaking hydrant I saw? How about the water oozing up onto the surface from a leaking pipe in the street?' You are right. There is much leakage from defects in the distribution system; surveys completed about 10 years ago found that nearly 35 million gallons of water a day were being lost through such leaks. However, we are going after those leaks . . . . Leaks totaling over 10 million gallons a day have already been located and repaired.

"If we will all work together—those who provide the water and those to whom it is supplied—millions of gallons now wasted, or put to no essential use, can be made to do their full share in the war effort. We need to develop a new attitude toward water, new habits in the way we use it. If we feel about water just as we do about gasoline, sugar, and scrap metal, we will use water wisely. Let's get the habit."

In simple, telling terms Mr. Howland presents a problem and a solution. This issue is by no means confined to Philadelphia; water waste is inexcusable, wherever it may occur.

February on the Burma Road

Chinese Attempt Great Progress in Spite of Difficulties, Says Arthur B. Morrill, M. Am. Soc. C.E., in Letter to Detroit Friends

Kunglang, Menghua Hsien, Yunnan Province
February 13, 1942

"*Dear Friends:*

"Most of the people I write to must have only a vague idea what things are like in these parts. It is much different from any place I ever saw when I lived in China before, although a little like the country outside the Great Wall between the Eastern Tombs and Jehol.

"A lot of things happened in China in the 27 years that I was absent—more fundamental things, I should say, than happened in America in the same length of time. Of course the automobile age came to America. Come to think of it, I have never stopped to evaluate the changes that have come to America in the 30 or 40 years that I have known it pretty well. But the changes still seem more basic in China.

Great Changes in China

"The bound feet for women have gone, except for women who are rather old. I see some women with nearly natural feet who are old enough so that their feet must have been bound for some years before the Revolution. And the general attitude of women has changed. When I meet them along the road they look at me with the same kind of mild curiosity a man would show, instead of ducking off to the side like a scared chicken, as they did before 1911.

"One of the interesting differences between China and America is the unimportance here of a young woman's legs. Perhaps that is to be expected in the case of the mountain peasant women, who trudge down from the hills with 50 or 60 lb of firewood slung from the top of their heads. They have no time, clothes, or energy to waste on sex appeal. But it is also true for the better-dressed young women of Kunglang, whose husbands perhaps work on the railroad and who knit sweaters from expensive balls of Kunming yarn. When they go down to the river bank to rinse out a few clothes they squat down with their long coats pulled well above the knees. Meanwhile the passers-by on the levee go on about their business and pay no attention whatever. I am afraid I would have a hard time explaining to the Chinese why it should be otherwise.

"But they also have taken the Chinese language apart since I was here before, and put it together in several different ways. There are two new ways of arranging characters in dictionaries. In one they are grouped by the total number of strokes, irrespective of radicals. All those of twelve strokes, for example, are divided into four classes, according as the first stroke is horizontal, downward to the left, vertical, or downward to the right. The strokes of the last group are usually only those tadpole-shaped dots. This method is quick if you are quite sure of the number of strokes, as when you have the printed or very clearly written character.

"The other method, which I cannot use, is said to be the best of all by those who know it well. It was developed by a scholar who heads the Commercial Press and is called the 'four corner' method. He divided into four simple groups all possible strokes that can occur in the corner of a character. These are numbered from 1 to 9 and some use is made of the zero.

A Young Chinese with Wide Interests

"A clever young man who works in one of the railway offices loaned me a geography arranged by the second method. This lad's name is Wang Yun and he is quite a fellow. He was much pleased to find, as he said, 'in a Chinese jungle,' someone who could help him in English. He already speaks quite well. His family is from around Shanghai but he was brought up in Peking and educated in a Russian-speaking school in Harbin. He worked for several years in Siberia and speaks Russian better than English. He has a long-time project of writing a Chinese-Russian dictionary, as he says there is no complete work of the kind. He rides horseback, keeps three hens, practices calligraphy every day, and strives after learning and culture in several other directions. He has a seal carved in Shou Shan Shih by his uncle, who is apparently

also a gentleman and a scholar. Shou Shan Shih means Longevity Mountain Stone and is very much prized for seal stones. It comes I think from some place in Fukien. It is a sort of rose brown but I have not been able to find out what mineral it is. It looks a little like marble and a little like onyx.

"Wang Yun practices his calligraphy from a book which he has, showing forms of characters from ancient inscriptions. He writes 16 or 32 characters every day about two inches square, with unsupported arm. He points out the lack of "strength" and general inartistry of the characters made by village carvers of seals. Mine cost a dime, so if much art went into it, I got a bargain.

"My young friend comes two evenings a week and we talk about things. He is going to show me his calligraphy book. I forgot to mention that he sometimes spends the time between midnight and 2 a.m. copying the minute lettering of my *National Geographic* maps of the Pacific Ocean and the Indian Ocean. I guess he is going to copy the entire maps. Sometimes I wonder if he does not attempt to excell in too many things. He is an interesting lad and I can often get the low-down about things from him better than I can from much higher-ranking engineers in the railway organization. The two highest are not any too good in English, and sometimes they have reasons of policy for not telling all they know. But I think they would often tell more if they could speak more fluently.

New Year's Celebration an Important Event

February 14, 1942

"It is now another day, and a big day in Old China. Tomorrow is the Old Chinese New Year, and it seems to be the only new year there is, as far as the mountain farmers are concerned. Government employees date their correspondence and talk by the new calendar, but when it comes to giving a party, they celebrate on the eve of the Chinese New Year. Our staff is all mixed up in preparation for a feast tonight and I am invited. I am going to take over my pressure lantern, so they will have 200 to 300 candlepower for the party instead of 6 or 8. I am also planning to open one of nine cans of American cigarettes, although there are only about 8 smokers among the 20 men.

"The holiday spirit is already on. People are pasting up new strips of red paper on each side of their doorways, lettered with big black good-luck characters for the coming year. They have been selling special holiday goods in the streets for weeks and today a few mountain women have brought in big baskets full of little sprays of pine with very long green needles. The people along the main village street do their best to maintain little trees at places in the rough stone pavement in front of their houses. The trees have a hard time in the hurly-burly of market days and among the hazards of frequent donkey caravans. Where a growing tree had finally failed they were setting up the other day a sturdy pine Christmas tree, stuck in the ground and made rigid by short pine stakes driven in alongside its trunk.

"Some of the railway men have left town and those that are left don't seem to be doing much work. Those downstairs under me are whistling and talking and probably helping in the preparation for some big party. For four or five days they don't expect to get much construction work done. Market day comes round every six days as regular as clockwork, but we were forewarned that we should have 12 days' supplies on hand this time. A market is due on the second day of the old new year, but probably few of the regular vendors will appear.

How News Releases Come Through

"The extent of news that Kunglang gets from the outside world every day comes here by radio telegraph, condensed at Kunming or Sian from news broadcasts from Chungking. They make several copies at the local office of the railway telegraph and send one to us. The black characters at the lower left say "Kang Yao Tuan," which means "Anti-Malarial Commission." The official name of our outfit is the American Medical Commission, but that doesn't worry the Chinese. They have had anti-malarial commissions before, of nation and province, and so the name is familiar. If we use it in Chinese we have a much better chance of being understood.

"I receive in English the news translations that one of the entomologists makes for me. He does them for an English exercise and I correct them. I am glad to get the news but I wish a little good war news would come along once in a while.

"The way our work proceeds would drive a more energetic person than I to drink. Five of the 16 members of our commission had not crossed the Pacific when the war put an end to clipper flights. They started for China by boat, somewhere and 'somewhen'—a garbled cablegram discloseth not. At least they have not appeared. Two of them should be here with me. As it is, I am the only American for this division of the railway, 195 kilometers (km) of line. It is almost a rule in this mountain country that the length of track is twice the straight-line distance between the termini. So the two ends of my division must be about 60 miles apart. The Kunglang river, which the railroad is following at this point, has an average grade of about 6%. As the maximum grade allowed on the railway is 3%, the locators have to hook back in the main valley or run up a side valley once in a while, in order to get enough distance to make the difference in elevation necessary. I don't know much about railroad building, but I never saw anything like this. In one length of 1 km, half of the distance is either tunnel or viaduct.

"One of the missing members of the commission is the executive officer, who was expected to run the business in Lashio so that the chief, Dr. Haas, could get out and see us in the sticks. In his absence, Dr. Haas has had to spend a good part of his time between Rangoon and Lashio, wangling our supplies off of ships, through the formalities, and up to Lashio. So he has never been into this division and has little time to help with our minor difficulties.

A Few Notes on Living Conditions

"Labor and personnel of all kinds are hard to get. A month ago I wrote to the director general's office, 70 miles from here, to send us an office man, a cook, and a house servant. The director general is likely in Kunming, Chungking, or Calcutta, struggling with bigger fish, but we hope to get some action from whomever he left in charge. But there are no results yet. For a week or two our senior staff did their own cooking and dishwashing as best they could, the physician acting as chief cook. Finally we located a poor cook and a servant here, but we can't bring in many more of our sanitary inspectors until we get a better cook to help feed them.

"There are 49 inspectors waiting at Mitu, the railroad general headquarters 70 miles away. Some of them were living in a very dirty old temple, sleeping on the floor. Some have been there two months, on salary, but doing no work. Their food costs them much more, living from day to day in restaurants, and their incomes are very low. Because of increasing inflation their pay should be adjusted frequently but I have not yet accumulated enough evidence to justify such action with the red-tape artists in Lashio. When I do get the dope it will take ten days for a round-trip telegram to Lashio. Air mail letters would take two or three weeks, including the long drag over the highway from here to Kunming to get the plane.

The Problem of Supplies

"Some of our supplies from America have not yet reached Rangoon and the pesky Japs may take the place before they can be brought through. When the war broke out our tons of quinine were stored in Java. They are considering flying the quinine to us. We are not in bad malaria country but I have a little stock of quinine for our staff, also a bottle of atabrine tablets that I am saying nothing about. But we haven't enough quinine in sight to begin to do anything for the railway laborers.

"My trunks got here six days ago, for which the Lord be thanked. So I have lots of canned goods, and a good many more underclothes and socks than I have had. I have been wearing nearly everything I had with me but just about the time my trunks arrived the weather seemed to get milder. I am now down to one pair of trousers, one shirt, and no hat in the house, although I am still wearing both summer and winter underwear. My shoe soles were worn through and my shaving soap was almost gone, so the trunk arrived just in time, four months after I started it off from Detroit. So you see it's a great life.

"Very truly yours,
"ARTHUR B. MORRILL"

Occasionally letters of interest come to our attention from members in out-of-the-way places. This message was written to engineers in Detroit, and was distributed to local members by the Michigan Section. Mr. Morrill went to Burma to take charge of the sanitation of the Burma Road railroad construction project. Rumor has it that "he got in and out just ahead of the Japs and is now in India."—EDITOR.

Fall Meeting at Niagara Falls, Canada

By action at its Minneapolis meeting, the Board of Direction confirmed the previously tentative plan of holding a regular Fall Meeting of the Society in October. The site chosen was Niagara Falls, Ontario, Canada, and the hostelry is the General Brock Hotel, overlooking the Falls. Set for the middle of October, the meeting conforms to the schedule of past years. The dates are Wednesday and Thursday, October 14 and 15.

Many considerations emphasize the desirability of a meeting at Niagara Falls. The site is central and the rail facilities are good. Further, this is a region of great engineering and scenic interest. But more particularly it is hoped that this may be a joint meeting with the Engineering Institute of Canada and that a generous number of Canadian engineers will be able to attend.

This meeting will thus have an international flavor, and will renew happy associations with Canadian engineers. The last similar occasion was at Vancouver in July 1934, and previous to that there was the Fall Meeting in Montreal in 1925. In the meantime the Society has made group visits to the vicinity at least twice—at the time of the Buffalo Meeting in the summer of 1928 and during the Rochester, N.Y., Fall Meeting in 1938, when one of the ladies' inspection trips included the Falls.

Technically the meeting should prove attractive. A number of Divisions have asked that time be reserved for them for one or more sessions, and many of the speakers it is hoped will be Canadians who will tell of what is new in Canada. The program will be built around some or all of the following Technical Division sessions: Construction, Engineering Economics, Highway, Power, Soil Mechanics and Foundations, Structural, Surveying and Mapping, and Waterways.

In accordance with the spirit of the times, emphasis will be placed on the engineer's contributions to success in the war. There will be social attractions but these will be subsidiary to the more serious technical features. It was felt that an extended program was hardly appropriate at this time and accordingly two days only will be set aside for the technical program. This will be supplemented by other conferences and committee gatherings as required.

Those members who can adjust their activities so as to attend the Niagara Falls Meeting in October will find themselves amply repaid.

Annual Meeting—American Institute of Architects

The American Institute of Architects held its Annual Meeting in Detroit, Mich., June 23, 24, and 25. Closely cooperating with the architects and joining in several of their sessions were members of the Producers' Council, which organization held its twenty-first anniversary and annual meeting simultaneously.

In the midst of all-out war activities, the main theme of the meeting, of course, dealt primarily with the architects' relationship to the war, both present and post-war. A rather sanguine view was taken of the existing status of the architects and of the producers of materials as well. It was noted that there is heavy unemployment in the architectural field and also that whatever building is now progressing is either directly for the Government or for projects related to the war effort. It is not to be wondered at that the architects view this situation with alarm. Complaint was also voiced that civil engineers had been assigned to work in Army camps which should rightly have gone to architects. And yet the general spirit of the meeting was one of optimism—that during the war the architect can apply himself diligently to the task at hand.

High lights of the meeting included addresses by Senator Thomas of Colorado, who prophesied a long period of war, from which a new world of free nations ultimately will arise; by John B. Blandford, Jr., Administrator of the National Housing Administration; Alfred F. Beiter, Representative of the Forty-first Congressional District of New York; and Alfred B. Tibbetts, chairman of the Committee on Architectural Cooperation of the Producers' Council, all of whom discussed the "Architectural Profession Today." Also, on the occasion of the annual dinner, Lt. Gen. William S. Knudsen spoke briefly.

One of the most interesting spots on the program was the afternoon session in the amphitheater at Cranbrook, a newly developed suburban school in the naturally beautiful rolling area north of Detroit. Here the architect and the landscape architect have been given carte blanche, which has resulted in a finished product of rare grace and beauty.

The election of officers produced no changes in the higher grades, R. H. Shreve of New York being continued as president, Dean Walter R. MacCormack of Cambridge, Mass., as vice-president, and Charles T. Ingham, of Pittsburgh, Pa., as secretary. For the Producers' Council, James W. Follin, M. Am. Soc. C.E., is managing director.

The meeting was well attended by members and their wives; the sessions were interesting; the weather was perfect; and in spite of the war gloom, the entire program could be called highly successful. For the report of this interesting meeting, from which the foregoing is condensed, we are indebted to James W. Orton, Assoc. M. Am. Soc. C.E., who represented the Society as official delegate.

News of Local Sections

Recent Activities

Buffalo Section

On June 30 members of the Buffalo Section heard an illustrated talk on "Aerial Bombardment Protection." This was given by John McManus, Director of Extramural Courses in Engineering for Cornell University. Mr. McManus spoke from the point of view of structural engineering design and discussed the problems encountered in trying to adjust theories of design to the unusual conditions produced by demolition bombing. "A 500-lb bomb with a terminal velocity of 1,000 ft per sec," he pointed out, "has a kinetic energy of 750,000 ft, while its explosive energy may be as much as 100 times this value. Under these conditions calculations of normal stress and bearing loads may not be applicable, for these forces take place in an extremely short period of 0.02 sec, with the pressure wave of the explosion lasting 0.005 sec and the suction wave of the explosion lasting four or five times that long. . . . The best method of designing to protect against such bombardment is to observe results in Europe and test results made in this country, notably at the Edgewood Arsenal."

Following his talk John W. Cowper, Director of the Society, spoke briefly on the same subject and emphasized the necessity for engineers to maintain their interest in the matter.

Central Ohio Section

At a meeting held at Ohio State University on May 12 it was announced that this year's recipient of the Section prize of Junior membership in the Society is Norman E. Bradstock, of Ohio State. The technical program consisted of a talk by Clyde Moore, reporter for the *Ohio State Journal*, who gave an entertaining account of his experiences in the "newspaper world."

Kansas City Section

A varied program was enjoyed at the May meeting of the Kansas City Section. A talk by Tom Collins, raconteur and humorist, initiated the program, which included piano selections by Mrs. Mildred Howard Barney. The principal speaker was Rear Admiral Hayne Ellis, U.S. Navy retired, who is now in charge of civilian defense for Kansas City. Admiral Ellis gave a comprehensive picture of the whole Kansas City defense organization, emphasizing the role of the engineer in the defense effort.

Panama Section

At the May meeting of the Panama Section, which took place in Balboa on the 25th, Col. D. L. Weart reminisced on the subject of the Savannah (Ga.) District and the Mississippi River Commission. Beginning with a brief outline of Georgia's colonial history and natural developments, Colonel Weart described some of the dredging problems encountered in the Savannah District and the general history and effects of cutoffs on the Mississippi.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for September

Since the days when Washington assembled his Continentals, we have found it necessary in times of national peril to Provide shelter for hastily mustered armies. Clarence G. Beardslee, of the U.S. Engineer Office in Los Angeles, has gathered considerable historical data on the development of Army camp planning in the United States, and will present this material in an article scheduled for the September issue.

New York City has a larger per capita rubbish disposal problem than any other city in the country. Several methods for the disposal of garbage and rubbish have been developed through long years of experience. The article on the "Sanitary Land Fills in New York City," by Rolf Eliassen and Albert J. Lizee, contains valuable material on a method that has been found to give reliable and economical results in this metropolis.

In the chain of command and execution, a wide variety of maps is required by the nation's armed forces. An article on "Military Topographic Mapping," by Herbert B. Loper, will deal with this phase of the war effort. Available maps do not in all cases supply sufficiently accurate information in the form best suited for military purposes. Therefore the Corps of Engineers has undertaken a program of systematic revision and duplication, as explained in this article.

Throughout the arid western states, the first consideration of a new community is to secure a palatable and adequate water supply. Utah is in the area where the upper limits of population growth are very rigidly limited by the amount of water that can be made available. Ralf R. Woolley, with charts and photographs, clearly shows the relationship between water and community growth in this section of the country.

Two articles previously announced for the August issue have been postponed because of space limitations, and will appear in September, along with a variety of other subjects.

Welding Bulletins Issued

Two welding standards have recently been published by the American Welding Society. They are entitled *Standard Methods for Mechanical Testing of Welds* and *Definitions of Welding Terms and Master Chart of Welding Processes*. Both were prepared by technical committees of the American Welding Society and are revisions of earlier bulletins of the same title.

Standards Methods for Mechanical Testing of Welds describes in detail the principal mechanical tests applied, including those for density, soundness, tensile strength, shearing strength, and ductility (bend tests). The booklet includes sketches of the specimens and descriptions of the methods of testing and evaluating the results.

Definitions of Welding Terms and Master Chart of Welding Processes gives the standard definitions adopted by the American Welding Society. In addition there is an index in which all terms are listed alphabetically. Fifty-one illustrations assist in making the definitions clear, and a chart shows the subdivisions of the principal welding processes—forge welding, resistance welding, arc welding, gas welding, thermit welding, and brazing.

Both of these standards may be secured in bulletin form, at 40 cents a single copy, from the American Welding Society, 33 West 39th Street, New York City.

N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

The Engineers Club was jovial—two lumps in the second cup of coffee gave the members a pleasant sense of patriotic participation in the nation-wide effort to reduce the embarrassing oversupply of sugar. "I call it negative rationing," said Professor Neare. "But let's hear Guest Professor Jenney dispose of the Dog and Pup creeks 'picture puzzle'" [propounded in the June issue].

"All right, Noah. Here's a sketch that expresses the situation in simple, a, b, c's. With a and c known, the panorama camera was stationed so that angles ϕ were equal and maximum for the particular, but unknown, interval b. Find b if, by a coincidence, $x = b$."

Matt Mattix rose. "I found two values for x—one practical, one fanciful. For the practical one, let's draw circles ABP and PCD thru camera station and bridge abutments. Let their central line intersect the highway at S. Then the required equality and maximum will occur when the two circles are tangent externally at P and when S is their center of similitude. Radii of the circles will be to each other as $c : a$, here as $2 : 1$. Whence I computed $b = x = 150$ (and, incidentally, $SA = 325$, $\phi = \tan^{-1} 7/9$)."

"Right on the nose," complimented the Guest Professor.

"But I'm not thru yet. For the fanciful solution, I find $x = 0$ and ϕ indeterminate, approaching $63.4°$ as $x = b \to 0$. Theoretically, the fanciful solution means a bigger picture of each bridge than does the practical solution. Paradoxically, the panorama aperture must rotate thru $180°$, of which $126.8°$ is collimated on the ends of two geometric lines and $53.2°$ on point $B = C = P$. Don't take me too seriously when I deduce that a point appears about five-sixths as wide as the end of a line! Of course, this solution is not valid until someone invents an infinitesimal panorama camera."

"Thank you, Matt. You've asked and answered a deep question. We often encounter the awful infinite—less frequently the fanciful infinitesimal. Anything to add, Noah?"

"Just some interesting generalities. For any values of a, b, and c, with $\phi_a = \phi_c$ = a maximum:

$$x = \frac{\sqrt{abc(a + b + c)}}{a + c}$$

$$\tan \phi = \sqrt{\frac{ac}{b(a + b + c)}}$$

And when $x = b$:

$$b = \frac{ac(a + c)}{a^2 + ac + c^2} \quad \text{[or 0]}$$

$$\tan \phi = 1 - \frac{ac}{(a + c)^2} \quad \text{[or 2]}$$

The bracketed values are the fanciful solution.

"Our new problem is the tentative design for the Corregidor Memorial Monument, to be built atop that gallant rock after the Nipanzis have been weeded out. The base will be square, 100 ft on a side; the shaft nowhere thinner than 1 ft. Specifications will call for just one material—solid concrete, weighing 150 lb per cu ft—and will limit the mean pressure on each horizontal section to 450 lb per sq in. How tall may the shaft be?"

(Matt Mattix, who contributed the only correct solution, is regular David E. Hughes. A surprising number of contributors assumed that the camera must be twice as far from the center of Dog Creek as from the center of Pup Creek.)

Sketch of Problem Proposed in June Issue

Heard from a Member in Trinidad

Among the new bases leased to the United States by Great Britain is that at Trinidad, British West Indies. To most engineers Trinidad means little more than a spot on the map. But not so to P. A. Welty, M. Am. Soc. C.E., now Water Engineer at the U.S. Naval Operating Base there. Witness the following interesting extracts from a letter of his to Prof. John A. Focht, secretary-treasurer of the Texas Section, which was printed in the May issue of *The Texas Engineer*.

"I constantly think of the water supply and milk supply in war time. Shanghai, Hongkong, all blew up on account of the water.... Water is a problem on all of these islands. One might think that they are tropical and swamped with rain, but such is not the case. On some of the islands, the hills are paved and covered with corrugated iron and the ravines and gullies paved to conserve every drop of rain; wells *non sunt*.

"Whoever owns and controls the Panama Canal must do what we are doing now; an inspection of the map showing that chain of islands from Florida to Venezuela is sufficient to warrant this statement. It is too bad it cannot be done economically in peace times rather than under war pressure....

"We do not want these islands; some of the people, especially the English, think that we want them, but we have everything they have, sugar, copra, and even 13 million negroes....

"We flew down from Miami; we came by Navy Patrol planes and had a most interesting trip as we skimmed the islands en route and saw the towns, plantations, people, narrow-gage railroads, shipping, etc. When one comes by Clipper, he flies three miles up above the clouds and sees nothing. I have been here now for fourteen months....

"First five months spent most of time topogging a reservoir site, planning a dam 107 ft high. 1940–1941 are the driest years on record in over 90 years, and we became frightened, so we had to have water immediately and we set Mr. Dam aside and went after wells. We made test holes and explored and have had good success. We now have some fine deep wells and good temporary shallow ones. I am in charge of planning the water system and we are building it and a chain of reservoirs, $^1/_4$ million gallons each....

"To be free from censors censuring I cannot say much. We all had cameras but they are *verboten'*....

"Trinidad is interesting but the people not. This must have been a Garden of Eden when Christopher Colombo first saw it. Sea full of fish, trees full of bloom, and fruits and nuts, the ground full of roots good to eat like yams, etc. One did not have to work and could live well. A delightful climate—just now it is winter and no rain for four months, January to May, days hot, nights cool enough for blanket. Rest of year it rains a shower daily about noon, hot, moist, muggy—but it is as good as East Texas even at that. But the white man changed things. He enslaved the aborigine, who soon died. First Spanish, then French, then English, all exploited the people, the country, the resources.

"They brought in negroes as slaves and then freed them before we did (I think not from humanitarian reasons but to be relieved of responsibility of feeding and clothing them—they get them cheaper as citizens). The Chinese, Japs, Hindus, and others came as contract laborers and nearly all of them stayed when their time was up. Talk about a melting pot at home—what have we here? Groups of boys and girls all colors play hockey, tennis, etc., and boys all colors play football. They kick, elbow, and slug, even butt the ball with their head. Children everywhere are also playing baseball.

"There are about a half million people in Trinidad, I guess two-thirds negroes, Chinese 5%, Hindu 15%, and the remainder more or less mixed. The Chinese are accountants and storekeepers. A small percentage are English, French, Spanish, and run the show. There are no industries except farming, sugar, copra, cocoa, fish, lumber, etc. Rubber would grow on the island. Most of the food is shipped in and very little is grown here. Much of the island is taken up in large holdings; natives own no land, no chickens, garden, *nada nada*, so they are wholly dependent on low wages. With our work there is insufficient labor.

"The town is uninteresting, dirty, dark, and gloomy.... Americans can't go in business in accordance with the terms of the Lend Lease Bill and the natives have not been in America and do not know what Americans want. There are no ice cream parlors or coffee shops. A cafe is a place where they open a can of vienna sausage and advertise in box-car letters, 'American Hot Dogs.' Coffee is local grown, pulverized, and boiled, added to and reboiled—pot washed semi-annually if it gets too full of grounds.

"Occasionally a negro rises above the herd, by his own efforts, and he may marry in and be recognized socially. Most of the police and other offices are held by the blacks. Most of the food eaten is shipped in and some now is not so plentiful. Living was very high for us our first six months; houses are non-procurable. We now have our own barracks, mess halls, personnel houses. American food and our houses are all modern....

"There is fishing, boating, bathing, etc., but rum drinking is the national sport, I believe, and people pretty generally take it on, each according to his or her ability.

"You might be interested in the masonic lodges. I have visited many and go regularly to two. Some are composed of men from several races and there are negro lodges regularly chartered; negro members in all the lodges.... Some of the work is very interesting, and a few things I would like to see followed in the states....

"My work just now has been on precipitous slopes (believe it or not we have 52-deg slopes and on soil with vegetation, not rock); the grass is dead, slick as glass, and we have had some bad falls. We are out of hob-nails and sole material for the kind of shoes and boots we wear."

NBC to Broadcast Program on "The Engineer at War"

Radio programs dealing with the contributions of engineers to the prosecution of the war are being broadcast by the National Broadcasting Company on Thursdays, from 6:30 to 6:45 p.m., Eastern War Time, over its nationwide network. The series began on July 16 and is to continue for eleven weeks.

The idea of telling the world by radio about engineers and their war activities came from a series of radio programs put on the air in 1941 by the American Institute of Electrical Engineers. The success of this series led the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and American Institute of Chemical Engineers, to appoint three representatives of each society to form a committee to consider a possible program and report to their respective societies.

The committee began its deliberations before Pearl Harbor was attacked and had scripts under way on blackouts, bombs, and damage to structures. The declaration of war emphasized the importance of the proposed program. The National Broadcasting Company and the Office of Civilian Defense enthusiastically endorsed the committee's proposal. Controversial matters are included in the broadcasts and changes are made when requested by the OCD up to the minute that a program goes on the air. In this way the latest and most authoritative information is given.

The material has been prepared by eminent men or by those selected from their staffs because of special knowledge. The scripts have then been woven into a story which presents a few of the striking parts played by engineers in some of the more important fields.

The remainder of the program is announced by the committee as follows:

July 30. The Resistance of Structures
H. E. Wessman, M. Am. Soc. C.E., Professor of Structural Engineering, New York University
Walter D. Binger, M. Am. Soc. C.E., Commissioner of Borough Works, Manhattan, New York, N.Y.

August 6. The Navy, Ships
Admiral S. M. Robinson

August 13. Dry Docks and Ship Repair Bases
Rear Admiral Ben Moreell, M. Am. Soc. C.E.

August 20. Tanks and Tools, prepared by Chrysler Corporation

August 27. Airplanes, prepared by Wright Aeronautical Corporation

September 3. Petroleum Production, prepared by Robert E. Wilson, President, Pan American Petroleum Company

September 10. Power—Hydro, Steam Electric
Glen B. Warren, General Electric Company, and others

September 17. U.S. Engineer Corps in Peace and War

September 24. Communications in Action

This information was furnished by R. L. Sackett, M. Am. Soc. C.E., a member of the committee representing the national engineering societies. Society representatives are Waldo G. Bowman, chairman, Eugene L. Macdonald, and Harold E. Wessman.

Preventing Cutting and Welding Fires

OF SPECIAL INTEREST in connection with the war emergency, which calls for the preservation of all our facilities, is a pamphlet recently issued by the National Fire Protection Association entitled "Preventing Cutting and Welding Fires."

The burning of the *Normandie* as well as many other smaller conflagrations should emphasize the danger from fires caused by welding and oxyacetylene cutting. Yet these tools are most important in war industry, and they can be used with complete safety if the proper precautions are taken.

This pamphlet should be valuable to engineers interested in the safe operation of cutting and welding apparatus. It may be obtained at 10 cents a copy, or $7.50 a hundred, from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

Additional Honorary Degrees Awarded

THE JULY issue listed seven members of the Society who were awarded honorary degrees, during the past commencement season, for notable contributions to the profession. In addition, word of the following members similarly honored has reached the Society:

CAPT. GLENN S. BURRELL (CEC), U.S. Navy, Doctor of Engineering, Ohio State University.

GEN. EUGENE REYBOLD, Doctor of Science, University of Arkansas.

Engineering Regarded as Vital War Activity

IN THE daily press and elsewhere there is much evidence to indicate the high estimate placed by the Government on engineering and engineering training as essential to success in the war. Two notices of recent date are of interest in this connection.

One concerns the National Roster of Scientific and Specialized Personnel, a Government activity in which the Society has cooperated. The Roster has considered it necessary to notify the Selective Service officials that it considers a number of fields as "critical occupations," since they require unusual skill or training, that is, technical specialization. Accountants, chemists, meteorologists, and statisticians are thus noted. But the longest list of all concerns engineers, and includes many branches such as civil engineers, safety engineers, and transportation engineers—air, highway, railroad, and water subdivisions—to mention only those branches in which Society members might feel qualified.

Another indication that engineers are needed to win the war is found in a recent promulgation from the Office of Education. This office has been furnished a fund of $5,000,000 to aid needy and worthy students studying professional and technical subjects. Engineers are included in this category. Grants are limited to students already partially through their college work, who are able to complete their courses in two years or less. In return for a grant of up to $500 a year, the student must agree to work for the Government upon graduation.

Da Vinci Applies for an Engineering Job

DISCOVERED *in A Treasury of the World's Great Letters, by A. J. Widmer, M. Am. Soc. C.E., a letter of Leonardo Da Vinci to the Duke of Milan is remarkable for the expressed understanding of the military problems of the day—the late fifteenth century. Of human interest is the complete self-confidence of this extraordinary man. His self-laudatory letter won the position, which he held for sixteen years, until the French invaded the city and captured his employer.*

"Having, most illustrious lord, seen and considered the experiments of all those who pose as masters in the art of inventing instruments of war and finding that their inventions differ in no way from those in common use, I am emboldened without prejudice to anyone, to solicit an appointment of acquainting your Excellency with certain of my secrets.

"1. I can construct bridges which are very light and strong and portable, with which to pursue and defeat the enemy; and others more solid, which resist fire or assault, yet are easily removed and placed in position; and I can also burn and destroy those of the enemy.

"2. In case of a siege I can cut off water from the trenches and make pontoons and scaling ladders and other similar contrivances.

"3. If by reason of the elevation or the strength of its position a place cannot be bombarded, I can demolish every fortress if its foundations have not been set on stone.

"4. I can also make a kind of cannon which is light and easy of transport, with which to hurl small stones like hail, and of which the smoke causes great terror to the enemy, so that they suffer heavy loss and confusion.

"5. I can noiselessly construct to any prescribed point subterranean passages either straight or winding, passing if necessary underneath trenches or a river.

"6. I can make armored wagons carrying artillery, which shall break through the most serried ranks of the enemy, and so open a safe passage for his infantry.

"7. If occasion should arise, I can construct cannon and mortars and light ordnance in shape both ornamental and useful and different from those in common use.

"8. When it is impossible to use cannon I can supply in their stead catapults, mangonels, trabocchi, and other instruments of admirable efficiency not in general use—in short, as the occasion requires I can supply infinite means of attack and defense.

"9. And if the fight should take place upon the sea I can construct many engines most suitable either for attack or defense and ships which can resist the fire of the heaviest cannon, and powder or weapons.

"10. In time of peace, I believe that I can give you as complete satisfaction as anyone else in the construction of buildings both public and private, and in conducting water from one place to another.

"I can further execute sculpture in marble, bronze or clay, also in painting I can do as much as anyone else, whoever he may be.

"Moreoever, I would undertake the commission of the bronze horse, which shall endure with immortal glory and eternal honour the auspicious memory of your father and of the illustrious house of Sforza.

"And if any of the aforesaid things should seem to anyone impossible or impracticable, I offer myself as ready to make trial of them in your park or in whatever place shall please your Excellency, to whom I commend myself with all possible humility."

Brief Notes

PURDUE University announces that a new edition of the Proceedings of the Purdue Conference on Soil Mechanics (held in September 1940 under the joint sponsorship of the Society for the Promotion of Engineering Education and the School of Civil Engineering and the Engineering Extension Department at Purdue) is now available. Copies may be obtained by writing to the Engineering Extension Department, Purdue University, Lafayette, Ind. The price is $4 to residents of the United States, and $4.50 to all others.

* * * *

PROCEEDINGS of the Fifth Texas Conference on Soil Mechanics and Foundation Engineering—held at the University of Texas in February 1942—are now for sale at $2 per set. Application for these sets should be made to the University of Texas at Austin, Tex.

* * * *

PUBLICATION of the following papers and reports presented at its 21st Annual Meeting is announced by the Highway Research Board: *Proceedings*, Vol. 21, cloth, price $3.25; *Roadside Development Reports*, multilith, price $1.00; and *Highway Research Abstracts*, mimeographed bulletin, 10 issues annually, subscription $1.50 per year. Associates of the Highway Research Board receive the *Proceedings* and the *Abstracts* by paying $3.00 yearly dues. Address the Highway Research Board, National Research Council, 2101 Constitution Avenue, Washington, D.C.

NEWS OF ENGINEERS

Personal Items About Society Members

George Kumpe, major, Corps of Engineers, U.S. Army, has been named district engineer at Milwaukee, Wis. He was formerly in the U.S. Engineer Office at Cleveland, Ohio.

William Griffith Sloan, of Princeton, N.J., has accepted a position with the Cuban National Development Commission, for which he will supervise repair of the Central Highway between Pinar del Rio and Santiago, Cuba.

Jerome O. Ackerman, lieutenant, Corps of Engineers, U.S. Army, has been appointed area chief engineer in charge of the Gopher Ordnance Plant. Before being called to active duty Lieutenant Ackerman was in charge of design and specifications in the U.S. Engineer Office at St. Paul, Minn.

A. H. Stevenson, until recently in the New York State Health Department at Gouverneur (N.Y.), has been commissioned a first lieutenant in the U.S. Public Health Service and is stationed in New York City.

Ray A. Campbell is now city engineer of Laramie, Wyo. He was previously engineer and construction superintendent for the Deal Lumber Company at Laramie.

Perry A. Fellows has been appointed Assistant WPA Commissioner in charge of the Division of Operations. Mr. Fellows has been chief engineer of the WPA since December 1940 and will continue in that capacity while assuming the additional duties of the head of the Division. His headquarters are in Washington, D.C.

Paul Shields Bailey, is now a captain in the Corps of Engineers, U.S. Army, stationed at Terre Haute, Ind. He was formerly with the Colorado State Highway Commission.

Francis L. Castleman, Jr., has resigned as associate professor of structural engineering at Vanderbilt University in order to become professor of civil engineering and head of the department at the University of Connecticut.

Frederick P. Dillon, commander, U.S. Coast Guard, has been relieved of his duties in the office of the District Coast Guard Officer for the Ninth Naval District at Cleveland, Ohio, and assigned to new duties in Washington, D.C.

Richard King, until lately instructor in civil engineering at the University of Connecticut, reported for active duty on June 15 as first lieutenant in the Sanitary Corps at Fort Belvoir, Va.

J. S. Bright and Charles C. Morris, respectively construction engineer and senior highway engineer in the San Francisco office of the Public Roads Administration, have been transferred to Seattle, where they are in charge of field operations on the Alaskan Highway Project. L. I. Hewes, chief of the western region of the Public Roads Administration, will retain San Francisco as his headquarters for directing the work.

Thomas K. McManus, of Berkeley, Calif., has been assigned to the instruction staff of the U.S. Military Academy at West Point, N.Y. He now has the rank of lieutenant in the Corps of Engineers, U.S. Army.

T. M. Price is now construction manager for H. J. Kaiser Company, Inc., on the new steel plant being built by that firm at Fontana, Calif. He was formerly vice-president of Panama constructors, Inc., at Cocoli, Canal Zone.

James T. Hester, for the past five years office engineer for Joint State Highway District 10 at San Francisco, Calif., has been commissioned a first lieutenant in the Corps of Engineers, U.S. Army. He is temporarily stationed in Louisiana.

Arthur V. Sheridan, previously planning commissioner for New York City, has been named commissioner of borough works of the Borough of the Bronx.

Claude S. Wilson recently severed his connection with the Fort Smith (Ark.) Structural Steel Company in order to become structural engineer for the John F. Beasley Construction Company, of Muskogee, Okla., and Dallas, Tex.

David H. Askew, maintenance bridge engineer for the Texas State Highway Department, has been called to active duty as a lieutenant (jg) in the U.S. Navy.

Lacey V. Murrow has been promoted from the rank of lieutenant colonel in the Corps of Engineers, U.S. Army, to that of colonel. He is located at Fort George Wright, Spokane, Wash.

Walter H. Hill, consulting engineer of Grangeville, Idaho, has become connected with the Corps of Engineers at the Umatilla Ordnance Depot at Hermiston, Ore.

Carroll L. Mann, Jr., now has been promoted from the rank of captain in the U.S. Corps of Engineers to that of major. He is serving as area engineer at Fort Bragg, N.C.

Guy A. Watkins was recently appointed acting district engineer for the Farm Security Administration at Little Rock, Ark., succeeding George H. Barton, who has been called to active duty in the U.S. Corps of Engineers. Mr. Watkins was formerly utility engineer for the F.S.A.

Frederick W. Hartmann has been granted an indefinite leave of absence from his position as assistant district manager in charge of the Chicago office of the Pittsburgh Equitable Meter Company in order to join the armed forces. He has been inducted into the Corps of Engineers, with the rank of captain.

C. W. Muhlenbruch, Jr., is now assistant professor of civil engineering at the Carnegie Institute of Technology. This appointment represents a promotion from the position of instructor.

Frederick C. Taylor, planning engineer for the Michigan State Highway Department, has accepted an appointment as transportation consultant to the War Department and will report for duty in Washington, D.C. He will continue in an advisory capacity with the State Highway Department.

Adolphus Mitchell is on a leave of absence from his position as senior traffic engineer for the North Carolina State Highway and Public Works Commission in order to do special work in connection with traffic conditions at a North Carolina marine airbase.

Daniel V. Terrell, professor of civil engineering at the University of Kentucky, has been appointed assistant dean of the engineering college there.

Rolf Eliassen, associate professor of sanitary engineering at New York University, has received the commission of captain in the Corps of Engineers, U.S. Army. He has been assigned to the North Atlantic Division office in New York, where he will serve as assistant division utilities officer in charge of water, sewage, and refuse disposal operations.

Boris W. Boguslavsky is now associate professor of structural engineering at the University of Akron (Ohio). He was formerly assistant professor of civil engineering at the University of Utah.

Henry George Schlitt was recently appointed bridge engineer for the Nebraska State Highway Department, succeeding the late John Glenn Mason. Mr. Schlitt was previously assistant bridge engineer.

DECEASED

Herbert Scandlin Battie (Assoc. M. '16) civil engineer with the Carolina Steel and Iron Company, of Greensboro, N.C., died on June 5, 1942. Mr. Battie had been in the engineering department of the Universal Portland Cement Company, of Chicago, and in the sales department of the Acorn Refining Company, of Cleveland. More recently he was engineering inspector of materials for Froehling and Robertson, Inc., Greensboro, N.C.

Charles Edward Bowron (M. '38) consulting engineer of Birmingham, Ala., died at his home in that city on June 17, 1942, at the age of 71. A native of England, Mr. Bowron was educated in this country (Vanderbilt University) and spent his career here. He had been engineer for the Tennessee Coal, Iron and Railroad Company at Birmingham, and chief engineer for the Gulf States Steel Corporation, at Gadsden, Ala. For some years he had maintained a private practice in Birmingham.

Charles Meirs Denise (M.'10) former general manager of sales of fabricated steel construction for the Bethlehem Steel Company, died suddenly at his home in Bethlehem, Pa., on June 12, 1942. Mr. Denise had spent his entire career in the steel industry, and was with the McClintic-Marshall Company from

1903 until 1931 when the company was acquired by Bethlehem Steel. He was then appointed vice-president in charge of the sales department, and from 1936 until his retirement last October was general manager of sales.

CHESTER WATERS LARNER (M. '12) president of the Larner Engineering Company, of Philadelphia, Pa., died at his home in Germantown on June 11, 1942. Mr. Larner, who was 61, was a pioneer in the design of hydraulic machinery for water power plants. From 1902 to 1906 he was designer for the Cramp Shipbuilding Company, in Philadelphia, and from 1907 to 1917 hydraulic engineer for the Wellman-Seaver-Morgan Company of Cleveland. In 1918 he became president of the Larner-Johnson Valve and Engineering Company (later the Larner Engineering Company).

FRANCIS DOUGLAS MAHONE (M. '25) designing engineer for the Petroleum Rectifying Company of California, Los Angeles, Calif., died on May 16, 1942. He was 56. For some years Mr. Mahone was in Hawaii, where he was engaged on the construction of Schofield Barracks and numerous other projects. During the World War he served overseas with the A.E.F. and, later, was with the Army of Occupation. From 1920 on he was with the Petroleum Rectifying Company.

CHARLES STERLING MILLARD (M. '05) vice-president and general manager of the Cleveland, Cincinnati, Chicago and St. Louis Railway Company (a subsidiary of the New York Central), died in Cincinnati on June 5, 1942. Mr. Millard, who was 68, had spent his entire career in railroad work. He had been with the Pennsylvania; the Delaware, Lackawanna and Western; and the Peoria and Eastern (another subsidiary of the New York Central). Since 1924 he had been vice-president and general manager at Cincinnati. He served as president of the Cincinnati Union Terminal Company in 1939.

CLIFFORD COOK NEWSOM (M. '32) associate highway engineer for the Public Roads Administration at Atlanta, Ga., died in that city on May 14, 1942. Mr. Newsom spent a number of years as district engineer for the Indiana State Highway Commission at Crawfordsville (Ind.). He had been with the Public Roads Administration in Georgia since 1933.

HENRY BLANCHARD PRATT (M. '17) who was with the New Hampshire State Highway Department at Concord, N.H., died suddenly on June 4, 1942, at the age of 65. For a number of years Mr. Pratt was with J. R. Worcester and Company—from 1907 to 1915 as assistant engineer in charge of the company's Waltham (Mass.) office. Later he was a member of the general contracting firm of Caughey and Pratt at Antrim, N.H.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

WALLACE CARL RIDDICK (M. '24) since 1937 dean emeritus of engineering and professor of hydraulics at North Carolina State College, Raleigh, N.C., died in a Baltimore (Md.) hospital on June 9, 1942. Dr. Riddick, who was 77, had been on the staff of North Carolina State College since 1892. From 1916 to 1923 he was president of the college, resigning to become dean of the engineering school which he organized in the latter year. In addition to his teaching duties, Dr. Riddick served as consultant on numerous private and public projects in the state. He had been on the State Highway Commission and various other public boards.

SHERMAN HARRY STIVERS (M. '28) consulting engineer of Washington, D.C., died on January 5, 1942, though word of his death has just reached the Society. He was 53. Early in his career Mr. Stivers engaged in railroad work, having been with the Louisville and Nashville, the Pere Marquette, and the Atlantic Coast Line railroads. Later he was with the Mississippi River Commission and the Bureau of Valuation of the Interstate Commerce Commission. He had been in private practice since 1924.

HERBERT KIRKMAN WARD (Assoc. M. '17) resident engineer for the California State Highway Department at Redding, Calif., died recently at Horse Creek (Siskiyou County), Calif. Mr. Ward, who was 59, had been in the State Department of Public Works for a number of years. Earlier he was supervising engineer for the Fairbanks Division of the Alaskan Engineering Commission at Nenana, Alaska.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From June 10 to July 9, 1942, Inclusive

ADDITIONS TO MEMBERSHIP

AMBROSE, HARRY HARWOOD (Jun. '42), 129 Chestnut St., Cambridge, Mass.

AULD, DAVID VINSON (Assoc. M. '42), Asst. Supt., Water Dept., Dist. of Columbia, Dist. Bldg. (Res., 1403 Thirty-First St., N.W.), Washington, D.C.

BARSTOW, CARL KIVA (Jun. '42), Insp., California Shipbuilding Corp., 908 North Normandie Ave., Los Angeles, Calif.

BEETS, FRANK ARNOLD (Jun. '42), Designer, Black & Veatch, Box 549, Greenville, Miss.

BERRY, RALPH MOORE (Assoc. M. '42), Asst. Cartographic Engr., U.S. Coast and Geodetic Survey, Dept. of Commerce Bldg., Washington, D.C. (Res., 75 Connecticut Ave., Kensington, Md.)

BRESLER, BORIS (Jun. '42), Asst. Engr., Richmond Shipbuilding Corp., Shipyard 2, Richmond (Res., 1320 Spruce St., Berkeley), Calif.

BRYAN, FRANCIS EDWARD (Jun. '42), Engr., Richmond Shipbuilding Corp., Box 1078, Richmond, Calif.

BURMAN, EDWARD WILLIAM (Jun. '42), Junior Hydr. Engr., TVA, 511 Union Bldg., Knoxville, Tenn.

CAMPBELL, JACK P. (Assoc. M. '42), Maj., Corps of Engrs., U.S. Army, Missouri Ordnance Works, Louisiana, Mo.

CLAYMAN, HERBERT SIDNEY (Jun. '42), Structural Engr., Boeing Aircraft Co., Seattle (Res., 2602 North Puget Sound, Tacoma), Wash.

CULBERTSON, GEORGE DE LA ROCHE (Jun. '41), 6106 South East 39th Ave., Portland, Ore.

D'ALBA, LOUIS (Assoc. M. '42), Asst. Engr. (Civ.), U.S. Engr. Office, Charleston, S.C.

DARLING, PHILIP VAN INGEN (Jun. '42), Housing Specialist, National Housing Agency, 1600 Eye St., Washington, D.C. (Res., 2807 North Glebe Rd., Arlington, Va.)

DE LA CANTERA, FERNANDO (M. '42), Associate Engr. (Structural), U.S. Engr. Office, Honolulu, Hawaii.

DERRICK, EDWIN (Jun. '42), Junior Engr. (Structural), U.S. Bonneville Power Administration, 1300 North East Union Ave., Portland, Ore. (Res., 8745 Seventeenth Ave., N.W., Seattle, Wash.)

DICKERSON, ELLIS R. (Assoc. M. '42), Asst. City Engr., City Hall (Res., 602 Pennsylvania Ave.), Jackson, Miss.

DUNN, WILLIAM REDFIELD (Jun. '42), Ensign, U.S.N., 45 Farrington Rd., Croton-on-Hudson, N.Y.

ETINGEN, ABRAHAM JOEL (Jun. '42), Junior Constr. Engr. (Field), Bechtel-McCone-Parsons Corp., 601 West 5th St., Los Angeles (Res., 2612 Haste St., Berkeley), Calif.

EVERETT, LEON NEWTON (Jun. '42), Engr., Los Angeles Sales & Service Corp., 5741 South 1st St., Vernon (Res., 6342 1/2 Middleton St., Huntington Park), Calif.

FAIRCLOTH, JAMES MANNING (Assoc. M. '42), Associate Prof., Civ. Eng., Univ. of Alabama, University, Ala.

FLOCKHART, JOHN STEEL (Assoc. M. '42), Superv. Engr., Dept. of Public Works, City of Newark, 322 City Hall, Newark, N.J.

FRY, SHIRLEY GLEN (Assoc. M. '42), Junior Res. Engr., State Highway Dept., South Crockett (Res., 529 South Crockett), Sherman, Tex.

GAMMIE, ROBERT JAMES (M. '42), Chf. Engr., T. & P. Ry., 1003 T. & P. Bldg., Dallas, Tex.

GOODSON, RAYMOND LYLE, JR. (Jun. '41), Ensign, U.S.N.R., Box 98, Garland, Tex.

GOPLEN, RALPH ARTHUR (Jun. '42), Junior Civ. Engr., U.S.N., Mare Island Navy Yard, Vallejo (Res., 623 Thirty-Third St., Richmond), Calif.

HALL, HOWARD PICKERING (Jun. '42), 42 Alteresko Ave., Dorchester, Mass.

HARRIS, KENNEDY KENNETH (Jun. '41), Junior Engr. (Civ.), Engr. Board, War Dept., Fort Belvoir (Res., 195 Yale Drive, Alexandria), Va.

HECKMAN, JOE ROWE (Jun. '42), With U.S. Army, Army Post Office 816, Care, Postmaster, Box 11, New York, N.Y. (Res., Liberty Center, Ind.)

HECKMILLER, IGNATIUS ADAM (Assoc. M. '42), Asst. Engr., U.S. Geological Survey, 511 Board of Trade Bldg. (Res., 6041 Indianola Ave.), Indianapolis, Ind.

HENDERSON, GEORGE (M. '42), Colonial Engr., Barbados, B.W.I.

HILL, DONALD GRAYBILL (Assoc. M. '42), Associate Field Engr., TVA, Kentucky Dam, Gilbertsville, Ky.

Hoggan, Howard Ralph (Jun. '42), Security and Intelligence Officer, U.S.N., Naval Torpedo Station, Keyport, Wash.

Howard, John William (Assoc. M. '42), Asst. City Engr., Grade III, City Eng. Dept., City Hall (Res., 26 Victoria St.), Everett, Mass.

Howard, Ralph Strong, Jr. (Assoc. M. '42), Chf. of Projects, Inst. of Inter-American Affairs, Box 35, Port-au-Prince, Haiti.

Jacobs, Louis (Jun. '42), Ensign, U.S.N.R., Dist. Security Office, 1160 Bishop St., Honolulu, Hawaii.

Johnson, Carl William (Jun. '42), Junior Engr., Standard Oil Co. of California, 225 Bush St., San Francisco (Res., 2423 Haste St., Berkeley), Calif.

Johnson, Carleton Brown (Jun. '42), (C. A. Johnson & Son), 5123 Wesson Ave. (Res., 1362 Cadillac Blvd.), Detroit, Mich.

Kaar, Paul Harry (Jun. '42), Asst. Structural Engr., The Panama Canal, Diablo Heights, Canal Zone.

Kelly, Thomas Laughlin (Jun. '42), Concrete Designer, Chemical Constr. Co., 1250 Sixth Ave. (Res., 506 Amsterdam Ave.), New York, N.Y.

Kinneman, William Paul (M. '42), Design Engr., Raymond Concrete Pile Co., 140 Cedar St., New York, N.Y. (Res., 556 Highland Ave., Westfield, N.J.)

Knight, Mark Gieger (Jun. '42), R.R. 2, Sheridan, Ill.

Lee, Richard Szu-Mien (Assoc. M.'42), Asst. Engr., Waddell & Hardesty, 101 Park Ave., New York (Res., 166-11 Twenty-Seventh Ave., Flushing), N.Y.

Lowry, Stephen Tener (Jun. '41), Lt., U.S. Army, Company I, 11th Infantry, Army Post Office 860, Care, Postmaster, New York, N.Y.

Livermore, Joseph Mason (M. '42), Cons. Engr., U.S. Rubber Co., Scioto Ordnance Plant, Marion, Ohio. (Res., 450 Fairway Rd., Ridgewood, N.J.)

Lerch, Robert William (Assoc. M. '42), Maj., Corps of Engrs., U.S. Army, Letterkenny Ordnance Depot, Chambersburg (Res., 207 Thirty-Second St., Harrisburg), Pa.

Leonard, Charles Leo, Jr. (Jun. '41), Care, James Stewart Co., U.S. Naval Operating Base, Trinidad.

McCarthy, Harry Levingston, Jr. (Jun. '42), Transitman, J. G. White Eng. Corp., Lake Ontario Ordnance Works, Modeltown (Res., 825 Seventeenth St., Niagara Falls), N.Y.

Martin, William Clarence (Jun. '42), Instr., Northwestern Technical Inst., Northwestern Univ., Evanston, Ill.

Middleton, Stephen Roche (Assoc. M. '42), Associate Engr., Corps of Engrs., U.S. Army, U.S. Dist. Engr. Office, Fort Sam Houston (Res., 348 Morningside Drive, San Antonio), Tex.

Miller, DeWolfe Hugo (Assoc. M. '41), Capt., U.S. Army, Benicia Arsenal, Benicia, Calif.

Mosher, Lloyd William (Assoc. M. '42), Junior Civ. Engr., Dept. of Water Supply, City of Detroit, 706 Water Board Bldg. (Res., 14216 Montrose), Detroit, Mich.

Neff, Allison Cleveland (Assoc. M. '42), Mgr., The Ohio Corrugated Culvert Co., 218 Auditorium Bldg., Cleveland (Res., 3376 Dorchester Rd., Shaker Heights), Ohio.

Neumann, Frank (Affiliate '42), Chf., Section of Seismology, Div. of Geomagnetism and Seismology, U.S. Coast and Geodetic Survey, Washington, D.C.

Niebuhr, Theodore William (Assoc. M. '42), Engr., Caribbean-Archt. Engr., Army Post Office 868, Care, Postmaster, New York, N.Y. (Res., 132 Lindbergh Blvd., Bloomfield, N.J.)

Nordstrom, Carl Theodore (M. '42), Lt. Col., Corps of Engrs., U.S.Army, Operations Officer, Omaha Dist., 1709 Jackson St., Omaha, Nebr.

Othus, Percy Monroe (M. '42), Associate Engr., U.S. Army Engrs., 14th and Alder St. (Res., 3819 North East Wasco St.), Portland, Ore.

Parsons, Alfred Waugh (Assoc. M. '42), Associate Engr., U.S. Engrs., Fisher Bldg. (Res., 6942 North East Graham Pl.), Portland, Ore.

Petrino, Michael Anthony (Jun. '42), Junior Engr., U.S. Army Engr. Corps, 120 Wall St. (Res., 4715 Richardson Ave.), New York, N.Y.

Pettis, Charles Emerson (M. '42), Cons. Engr., Finkbeiner, Pettis & Strout, 725 Nicholas Bldg., Toledo, Ohio.

Pyle, Robert Frederick Macbeth (M. '42), Engr., 99 Twenty-Eighth St., Newport News, Va.

Reck, Charles William (Jun. '42), Junior Engr., Water Resources Branch, U.S. Geological Survey, Church St. (Res., 58 Warren St.), Ellenville, N.Y.

Rush, Alger Emanuel (M. '41), 3918 Old Kingston Pike, Knoxville, Tenn.

Sanders, James Edward (Assoc. M. '42), Associate Engr. (Hydr.), U.S. Engr. Dept., Vicksburg, Miss.

Silver, Edward Charles (Jun. '42), Asst. Civ. Engr., TVA (Res., 143 Underwood Pl.), Knoxville, Tenn.

Sperber, Philip (Jun. '42), Draftsman, Chemical Constr. Corp. 1250 Sixth Ave. (Res., 1456 Minford Pl.), New York, N.Y.

Stollard, Julian Howard (Jun. '42), Junior Hydr. Engr., U.S. Geological Survey, 625 Market St., San Francisco, Calif.

Stolz, John Francis (Jun. '42), 1911 Tomlinson Ave., New York, N.Y.

Stueber, Gustav (Assoc. M. '42), Superv. Designer and Squad Boss, United Engrs. & Constrs. Inc., 1401 Arch St., Philadelphia (Res., 4020 Dayton Rd., Drexel Hill), Pa.

Swatek, George Francis (Assoc. M. '42), Materials Engr., State Dept. of Roads and Irrig., State House (Res., 927 South 33d St.), Lincoln, Nebr.

Szeto, Chew Cheuk (Jun. '42), Junior Engr., Giffels & Vallet, Inc., 1000 Marquette Bldg., Detroit, Mich.

Taylor, Virginius Leslie (Assoc. M. '42), 1st. Lt., Corps of Engrs., U.S. Army, U.S. Engrs., Mobile Dist., Gulfport, Miss.

Walton, Norman James (Jun. '42), 2d Lt., U.S. Army, 82d Regiment, Fort Randolph, Canal Zone.

Warren, Alfred Wingate (Assoc. M. '42), (Lathrop-Hoge Constr. Co.), 111 West Washington St., Chicago, Ill.

White, Henry Martyn (Assoc. M. '42), Chf. Engr., W. N. Brown, Inc., 3420 Newark St., N.W., Washington, D.C. (Res., 1015 Crawford Drive, Rockville, Md.)

White, Lloyd Young (Assoc. M. '42), Dist. Engr., H. H. Robertson Co., 905 Washington Bldg., Washington, D.C.

Wilkins, Richard Cameron (Jun. '42), Ensign-V 7, U.S.N.R., 870 Sea View Drive, El Cerritol, Calif.

Wollin, Ernst George (Jun. '41), Junior Hydr. Engr., U.S. Geological Survey, 2922 North Dousman St., Milwaukee, Wis.

Young, Robert Meriwether (Jun. '42), 1st Lt., Infantry, U.S. Army, Eng. Office Bldg. 13, Camp Croft, S.C.

Membership Transfers

Ackerman, Jerome Otto (Jun. '36; Assoc. M. '42), 1st Lt., Corps of Engrs., U.S. Army, 1217 U.S. Post Office, St. Paul, Minn.

Arnold, Gerald Eugene (Assoc. M. '33; M. 42), San. Engr., U.S. Public Health Service, 1355 Market St. (Res., 477 Colon Ave.), San Francisco, Calif.

Barratt, Herbert John (Jun. '38; Assoc. M. '42), Plant Engr., Price Brothers & Co., Ltd., Riverbend, Que., Canada.

Bosland, Frank Everet (Jun. '34; Assoc. M. '42), Associate Highway Engr., TVA, Knoxville, Tenn.

Burke, Walter Anthony, Jr. (Jun. '29; Assoc. M. '32; M. '42), Lt., CEC U.S.N.R., Officer in Chg., Constr., Naval Ordnance Works, Louisville, Ky.

Cornelius, William Pascal (Jun. '36; Assoc. M. '42), Capt. Corps of Engrs., U.S. Army, Area Engr., 300 South Main St. (Res., 114 North Duluth), Sioux Falls, S.Dak.

Dominy, John Arthur (Jun. '35; Assoc. M. '42), Lt., CEC-V(S) U.S.N.R., Public Works Dept., U.S. Naval Air Station, Jacksonville, Fla.

Flanigan, Pierce John, Jr. (Jun. '34; Assoc. M. '42), Secy.-Treas., P. Flanigan & Sons, Inc., 2405 Loch Raven Rd., Baltimore, Md.

Gibson, Robert Clayton (Assoc. M. '23; M. 42), Asst. Bridge Engr., State Highway Comm., State Capitol Bldg. (Res., 410 North Spruce St.), Little Rock, Ark.

Givotovsky, Victor Timothy (Jun. '20; Assoc. M. '22; M. '42), Senior Structural Engr., Municipal Archt. Office, Govt. of Dist. of Columbia, 420 District Bldg., Washington, D.C.

Goldberg, John Edward (Jun. '31; Assoc. M. '42), Engr., Waco Aircraft Co., Troy, Ohio. (Res., 6530 South Sangamon St., Chicago, Ill.)

Hart, Harold Carter (Jun. '30; Assoc. M.' 42), Asst. Designing Engr., Water Bureau, Met. Dist., Hartford County, 1026 Main St., Room 702 (Res., 8 Nepaug St.), Hartford, Conn.

Heine, Francis A. (Assoc. M. '28; M. '42), Chf. Engr., Bureau of Water, City Hall, Reading, Pa.

Kelly, Henry Jervey (Assoc. M. '34; M. '42), Senior Civ. Engr., TVA, 703 Pound Bldg., Chattanooga, Tenn.

Kofoid, Orville (Jun. '32; Assoc. M. '42), Associate Civ. Engr., Public Works Div., U.S.N., Puget Sound Navy Yard (Res., 505 Eighth St.), Bremerton, Wash.

Kowitz, Arthur William (Jun. '32; Assoc. M. '42), Capt., Corps of Engr., U.S. Army, Army Post Office 5, Care, Postmaster, New York, N.Y.

MacConnell, Richard Joseph (Jun. '39; Assoc. M. '42), Asst. Hydrologic Engr., U.S. Weather Bureau, 1047 New Federal Bldg., Pittsburgh, Pa.

McCasland, Stanford Paul (Jun. '30; Assoc. M. '38; M. '42), Capt., Corps of Engrs., U.S. Army; Care, C. A. D. Young, U. S. Bureau of Reclamation, Denver, Colo.

Mahon, Justin David (Jun. '33; Assoc. M. '42), Civ. Engr., Underpinning & Foundation Co., Inc., 155 East 44th St., New York, N.Y. (Res., 34 Hill St., Morristown, N.J.)

Noall, James Wesley (Jun. '31; Assoc. M. '42), Capt., Quartermaster Corps, U.S. Army, Company D, 73d Quartermaster Battalion, Vancouver Barracks, Wash.

Patterson, Archibald Oscar (Jun. '30; Assoc. M. '42), Associate Hydr. Engr., U.S. Geological Survey, Box 503, Knoxville, Tenn.

Quiriconi, Eugene (Jun. '32; Assoc. M. '42), Designing Engr., The Ferber Co., 16 Johnson Ave., Hackensack, N.J. (Res., 71 Barrow St., New York, N.Y.)

Scofield, Walter Fleming (Jun. '40; Assoc. M. '42), Asst. Prof., Civ. Engr., Tulane Univ., New Orleans, La.

Starr, John Thornton (Jun. '37; Assoc. M. '42), Associate Civ. Engr., U.S. Engr. Office, Standard Oil Bldg., 9th Floor (Res., 2204 Chelsea Terrace), Baltimore, Md.

Wagner, William John (Assoc. M. '26; M. '42), R. of W. Agt., State Highway Dept., 329 South Kirkwood Rd., Kirkwood, Mo.

Reinstatements

Campbell, William Alden, Jun., reinstated July 7, 1942.

Conrad, Charles Sumner, Assoc. M., reinstated May 11, 1942.

Colicci, Pacifico Anthony, Jun., reinstated June 15, 1942.

Coulter, Richard Gallaher, Jun., reinstated June 8, 1942.

Moser, Cecil Ramsey, Assoc. M., reinstated June 29, 1942.

Stoecker, William, M., reinstated June 24, 1942.

Tsagaris, Dean Peter, M., reinstated June 22, 1942.

Resignations

Nichols, Kenneth David, Assoc. M., resigned June 30, 1942.

Reaves, John Cable, Jr., Jun., resigned June 10, 1942.

TOTAL MEMBERSHIP AS OF JULY 9, 1942

Members	5,794
Associate Members	6,985
Corporate Members	12,779
Honorary Members	35
Juniors	4,991
Affiliates	71
Fellows	1
Total	17,877

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

August 1, 1942 NUMBER 8

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

ARTHUR, LYNN JENNINGS, Bremerton, Wash. (Age 42) (Claims RCA 6.8 RCM 8.1) May 1940 to date with U.S. Navy Yard, Puget Sound, as Asst. Naval Archt. and (since Oct. 1940) Associate Structural Engr.; previously Res. Engr. Inspector, FWA.

BINTZ, WESLEY, Lansing, Mich. (Age 50) (Claims RCA 4.0 RCM 20.0) June 1923 to date Cons. Engr., specializing in swimming pools.

BOGREN, GEORGE GUSTAVE, Cochituate, Mass. (Age 42) (Claims RCA 5.6 RCM 10.4) March 1942 to date San. Engr., Stone & Webster Eng. Corporation; previously San. Engr., Weston & Sampson.

CRAWFORD, DAVID, Dixon, Ill. (Age 44) (Claims RC 8.0 D 7.0) June 1923 to date with Dist. 2, Div. of Highways, Illinois Dept. of Public Works and Bldgs., as Jun. Engr., and (since June 1927) as Asst. Engr., acting as Res. Engr., Chf. of surveys, Designer, etc.

ESSICK, PAUL JONES, JR., Philadelphia, Pa. (Age 53) (Claims RC 25.2 D 6.4) March 1936 to date Deputy Chf., Bureau of Highways and Street Cleaning.

FOX, ROBERT MYRON (Assoc. M.), Los Angeles, Calif. (Age 66) (Claims RCA 8.7 RCM 33.9) Aug. 1922 to date with Univ. of Southern California, as Asst. Prof., Associate Prof., and (since Sept. 1931) Prof., of Civ. Eng.

GOULD, JOHN JACQUES (Assoc. M.), San Francisco, Calif. (Age 44) (Claims RCA 6.6 RCM 11.7) Dec. 1935–Oct. 1939 Chf., Div. of Structural Eng., San Francisco Bay Exposition Co.; Jan. 1940 to date Cons. Engr.; in the interim with W. P. Day, Cons. Engr.

HERZBERG, WILLIAM, Birmingham, Ala. (Age 52) (Claims RCA 11.0 RCM 19.6) July 1921 to date with Alabama Highway Dept., as Res. Engr., Constr. Engr., Div. Engr., and (since Jan. 1939) State Constr. Engr.

JONES, JAMES EVERETT (Assoc. M.), Glendale, Calif. (Age 57) (Claims RCA 9.1 RCM 7.0) Jan. 1922 to Jan. 1940 Asst. Engr., and Jan. 1940 to date Civ. Engr., Dept. of Water and Power, City of Los Angeles.

KROENING, WALTER EDWIN (Assoc. M.), Greendale, Wis. (Age 39) (Claims RCM 12.1) June 1938 to date with FSA, U.S. Dept. of Agriculture, as Asst. Manager and Chf. Engr., and (since Jan. 1941) Community Mgr.; previously Senior and Chf. Designing Engr., Div. of Suburban Resettlement, RA, Washington, D.C.

LOUREE, CHARLES HAROLD, Oklahoma City, Okla. (Age 39) (Claims RCA 5.8 RCM 5.3) April 1942 to date Engr.-Designer, The Austin Co.; previously Estimator and Designing Engr., Patterson Steel Co., Tulsa, Okla.; Constr. Engr., Skelly Oil Co., Tulsa.

PADGETT, VERNON HARPER, Mobile, Ala. (Age 37) (Claims RCA 2.0 RCM 6.3) April 1942 to date associate Engr., Design Sec., U.S. Engrs.; previously with Alabama and Mississippi Highway Depts.

PARKER, JOSEPH SANDERS, Lexington, Ky. (Age 47) (Claims RCA 9.2 RCM 11.1) May 1941 to date Chf. Design Engr. with Allied Engrs. and Architects, and (since Aug. 1941) Wilson, Bell and Watkins, Lexington; previously Chf. Engr. with J. S. Watkins, Cons. Engr., Lexington.

ROBERTS, WILLIAM CALVERT, Baltimore, Md. (Age 46) (Claims RCA 9.3 RCM 12.3) April 1941 to date with Carr and J. E. Greiner Co., Baltimore, and Durham, N.C., as Project Mgr.; previously Project Engr., with J. E. Greiner Co., Cons. Engrs., Baltimore.

ROLLINS, EDWARD DEXTER, Chicago, Ill. (Age 50) (Claims RCA 5.7 RCM 16.0) Aug. 1935 to date Senior Engr., Div. Engr., and Gen. Supt., FWA.

ROSE, THOMAS DUNCAN, Chapel Hill, N.C. (Age 52) (Claims RCA 15.6 RCM 10.3) Aug. 1938 to date in private engineering practice; previously with PWA, Charlotte, N.C., in various capacities.

SUJAN, SHIVA BAGOMAL, Karachi City, India. (Age 40) (Claims RCA 7.3 RCM 8.8) Oct. 1928 to date with Concrete Association of India, as Asst. Engr., and (since Oct. 1933) Dist. Engr.

TAYLOR, CHARLES BAGWELL (Assoc. M.), Arlington, Va. (Age 48) (Claims RCA 2.8 RCM 15.7) April 1942 to date Lt. Comdr., CEC, U.S. Navy (R); previously Engr. and Owner, Taylorbilt Constr. Co.; Coordinator with Leo Sanders, Contr.

TAYLOR, MARVIN (Assoc. M.), Montgomery, Ala. (Age 47) (Claims RCA 11.1 RCM 8.2) Aug. 1932 to date with Alabama Highway Dept., in various capacities, since Jan. 1939 being State Maintenance Engr.

WILSON, DAVID MATHIAS (Assoc. M.), Los Angeles, Calif. (Age 45) (Claims RCA 2.6 RCM 14.2) Sept. 1929 to Sept. 1931 Asst. Prof., Sept. 1931 to Sept. 1937 Associate Prof., and Sept. 1937 to date Prof., of Civ. Eng., Univ. of Southern California.

APPLYING FOR ASSOCIATE MEMBER

BLANKENSHIP, LEON STEPHEN, Raleigh, N.C. (Age 34) (Claims RCA 8.6) Feb. 1940 to date Associate San. Engr., U.S. Dept. of Agriculture, FSA; previously with Tennessee State Health Dept., as Dist. Supervisor, and Dist. Sanitarian.

BROCKER, ROBERT JOHN, Irwin, Pa. (Age 48) (Claims RCA 14.5 RCM 8.2) Aug. 1927 to date in private practice as Archt. & Engr., Greensburg, Pa.

CUNNING, JOHN JOHN, Akron, Ohio. (Age 35) (Claims RCA 11.0) June 1925 to Oct. 1929, Dec. 1930 to Oct. 1935 and April 1936 to date with Ohio State Highway Dept., in various capacities, since Sept. 1940 as Field Engr.

DIETZ, JOHN RAPHAEL (Junior), Carbondale, Pa. (Age 30) (Claims RCA 3.3 RCM 1.0) March 1940 to date Highway Engr., Caribbean Archt-Engr., Ft. Read, Trinidad; previously Draftsman, J. E. Greiner Co., Baltimore, Md.; with Pennsylvania Turnpike Comm.

EBERHARDT, ANDREW, Evanston, Ill. (Age 34) (Claims RCA 3.0) Dec. 1939 to date with Harza Eng. Co., Chicago, Ill. and Charleston, S.C., as Senior Structural Draftsman, Structural Designer, and Asst. Chf. Designer; previously Structural Steel Detailer with Worden-Allen Co., Milwaukee, and with Milwaukee Bridge Co.

EGEBERG, HAROLD OSCAR, Fort Peck, Mont. (Age 42) (Claims RCA 6.0 RCM 4.0) June to Aug. 1941 and Feb. 1942 to date with U.S. Engrs., since Feb. 1942 as Associate Civ. Engr.; in the interim with U.S. War Dept., Fort F. E. Warren, Wyo.; previously with State Water Conservation Board, Helena, Mont.

FOSTER, JAMES HOMER, Louisville, Ky. (Age 42) (Claims RCA 4.2 RCM 9.5) 1938 to date Associate Hydr. Engr., 2^{2}/$_{3}$ years with U.S. Forest Service, and (since 1941) with U.S. Engr. Office; previously Asst. Hydr. Engr., U.S. Geological Survey, Water Resources Branch.

GABBE, HENRY WALTER, Huntsville, Ala. (Age 35) (Claims RCA 13.8) Feb. 1942 to date with Whitman, Requardt & Smith, Engrs. and Archts.; previously with Parsons, Klapp, Brinckerhoff & Douglas, Cons. Engrs.; Res. Engr. with Thomas & Mears, with Malcolm Pirnie, Cons. Engr. of New York City on work for City of Miami Beach, Fla.

GEARHART, JOHN CHASE (Junior), Portland, Ore. (Age 28) (Claims RCA 1.4 RCM 4.8) Dec. 1935 to date with Stevens & Koon, Cons. Engrs., as Jun. Engr., Superv. Engr., and Asst. Engr.

HEISS, EDWARD AUGUST, Seattle, Wash. (Age 36) (Claims RCA 5.3 RCM 4.6) Jan. 1934 to date with Wallace & Tiernan Sales Corporation, as Dist. Engr., Div. Engr., and (since July 1941) Div. Mgr.

HOLLENBECK, THOMAS ALEXANDER, Bremerton, Wash. (Age 35) (Claims RCA 6.1) Oct. 1941 to date Associate Civ. Engr., Puget Sound Navy Yard, U.S. Navy, Dept. of Public Works; previously with The Austin Co., Seattle, as Field Engr., and Mechanical Designer; with U.S. Engr. Office.

HUCKLEBERRY, BOWEN COMBS, Jr., Fort Brady, Mich. (Age 38) (Claims RCA 3.3 RCM 0.6) Sept. 1940 to date Officer, Constr. Div., QM Corps, U.S. Army, at present being 1st Lieut., in charge of U.S. Engr. Office, Sault Ste. Marie (Mich.) Mil. Dist.; previously with Eng. Dept., City of South Bend, Ind.; with U.S. Dept. of Agriculture, Bureau of Agr. Eng. and SCS.

JENKINS, DAVID SAMUEL, Waco, Tex. (Age 39) (Claims RCA 2.0 RCM 6.2) Dec. 1935 to

date Associate Hydr. Engr. and Hydr. Engr. Hydrologic Div., SCS.

KEY, LESLIE LORENZA, Bristol, Va. (Age 34) (Claims RCA 3.7) July 1941 to date Associate Engr., TVA; previously with E. I. du Pont de Nemours and Co.; with Mississippi Highway Dept.

LIGHT, EUGENE PERRY, Dearborn, Mich. (Age 35) (Claims RCA 3.5 RCM 8.4) June 1936 to June 1938 and Nov. 1938 to date Structural Engr.-Estimator, The Austin Co.; in the interim Design and Field Engr. with R. W. Ellis, Cons. Engr., Van Wert, Ohio.

LUNA, WILLIAM AUGUST, New York City. (Age 34) (Claims RCA 3.8 RCM 1.2) Nov. 1941 to date Safety Engr., Liberty Mutual Insurance Co.; previously Asst. Chf. Engr. with Clifford F. MacEvoy, Contr. and Engr., Newark, N.J.; Jun. Engr., QM Corps, Fort Hamilton, N.Y.; Engr. Asst., New York City Board of Water Supply; Field Asst., New York World's Fair 1939, Inc.; Chf. of Party with Pres., Borough of Manhattan.

MATHEWS, ALBERT ALDRICH, Confluence, Pa. (Age 27) (Claims RCA 3.2) June 1941 to date Chf. Engr., The Hunkin-Conkey Constr. Co. and Shofner, Gordon & Hinman, Youghiogheny Dam; previously Chf. Engr. with Floyd Shofner, Gen. Contr.; Asst. Res. Engr., Pennsylvania Turnpike Comm.; Surveyman, U.S. Engr. Dept.

NORRIS, LANGSTON HIRAM, Jr., Courtland, Ala. (Age 31) (Claims RCA 5.9) At present with Goodwin and Van Keuren, Engrs.; Feb. to May 1942 Asst. Prof. of Civ. Eng., Alabama Pol. Inst., Auburn, Ala.; previously with Alabama Highway Dept.

ROBERTS, JOSEPH MCCALL (Junior), Richmond, Ky. (Age 28) (Claims RCA 3.6 RCM 2.2) May 1940 to date with Hart, Freeland & Roberts, Archts. and Engrs.; previously with Freeland, Roberts & Co., Nashville.

ROSENKJAR, EINER, Los Angeles, Calif. (Age 35) (Claims RCA 5.5 RCM 0.4) March 1942 to date Asst. Engr. (Structural), U.S. Engr. Dept.; previously Asst. Structural Engr., City of Los Angeles; Draftsman and Asst. Engr. with S. B. Barnes.

SINGLETARY, EMORY GORDON, Greensboro, N.C. (Age 43) (Claims RCA 13.2 RCM 4.5) Jan. 1941 to date Gen. Supt. of Utilities, Grannis, Higgins, Thompson and McDevitt Co., Charlotte; previously Constr. Supt., V. B. Higgins Co., Greensboro, N.C.; at present Asst. Civ. Engr. (rank of Lieut.), U.S.N.R.

SMITH, MARLO ERNEST, Fremont, Nebr. (Age 28) (Claims RCA 1.5 RCM 2.0) Jan. 1942 to date with Giffels & Vallet, Inc., Archt.-Engr., as Chf. Draftsman; previously with Scott & Scott, Engrs, and Scott & Scott, Inc., Lincoln, Nebr.

STEVENSON, GEORGE FRANKLIN, Amite, La. (Age 36) (Claims RCA 8.2 RCM 0.5) Aug. 1935 to date Res. Engr., Louisiana Dept. of Highways.

STEWART, GEORGE CAMBRELENG, Bethlehem, Pa. (Age 34) (Claims RCA 8.5 RCM 2.0) Aug. 1927 to date with City of New York in various capacities, since July 1938 with Board of Water Supply, as Eng. Inspector, and (since July 1939) Asst. Engr.

STIERS, GEORGE MERLIN, Madill, Okla. (Age 35) (Claims RCA 7.7) Aug. 1941 to date Engr. and Gen. Supt., Amis Constr. Co., and (after April 1942) also J. Briscoe, Contr.; previously with Oklahoma Highway Dept., and Phillips Petroleum Co.

WETZEL, JOHN HENRY (Junior), Upper Darby, Pa. (Age 31) (Claims RCA 4.3 RCM 4.5) Aug. 1935 to date with SCS, U.S. Dept. of Agriculture, as State Engr., Asst. Regional Engr., Project Engr., Area Engr., and (since June 1941) Regional Safety Engr.

WRIGHT, JAMES DANIEL, Lynchburg, Va. (Age 40) (Claims RCA 16.5) March 1924 to date with Dept. of Public Works, City of Lynchburg, Va., in various capacities, since Feb. 1935 being Prin. Asst. Engr.

APPLYING FOR JUNIOR

BENTLEY, THOMAS ROSS, Ft. Worth, Tex. (Age 32) (Claims RCA 1.8) Nov. 1941 to date Senior Draftsman, with Prack & Prack, Archts., and Chester Engrs., and (since May 1942) with Ford, Bacon & Davis, Inc., Marshall, Tex.; previously with Freese & Nichols, Archts.-Engrs., Bastrop, Tex.; Sinclair Refining Co., Ft. Worth.

CHRISTENSEN, GEORGE JAY, El Cerrito, Calif. (Age 27) 1941 to date with Pacific Bridge Co., Alameda, Calif., previously with H. T. Gettins Co., San Francisco.

CLINGER, CHARLES BURKE, Dallas, Tex. (Age 24) (Claims RCA 1.6) Jan. 1942 to date Asst. City Engr., University Park (Dallas); since April 1942 on leave as Jun. Engr. with Koch & Fowler, Cons. Engrs. (3 weeks), and (since May 1942) Asst. Engr. with Myers, Noyes & Lemmon.

CULLMER, ROBERT EDWARD, Spring Valley, Calif. (Age 31) Sept. 1935 to date Special Inspector, Gas Distribution Dept., San Diego (Calif.) Gas & Elec. Co.

EPPLER, JOHN FREDERICK, Manhattan, Kans. (Age 27) March 1940 to date Instructor, Kansas State Coll.; previously with Crane Co., Chicago, Ill.

JONES, MORTIMER DRAHN, Dallas, Tex. (Age 26) (Claims RCA 2.6) April 1942 to date with Myers, Noyes & Lemmon, Archt.-Engrs.; previously Jun. Engr. with Koch & Fowler, Engrs.; Supt. of Constr. for A. E. Thomas, Archt.

LEE, JOHN CLIFFORD HODGES, JR., Anchorage, Alaska. (Age 24) (Claims RCA 0.5) 1941 B.S., U.S. Mil. Acad.; June 1941 to date 2d Lieut., Corps of Engrs., U.S. Army.

LEVINE, BERT, Charleston, S.C. (Age 25) 1940 B.S. in Civ. Eng., Univ. of S.C.; Dec. 1940 to date with U.S. Navy at Charleston (S.C.) Navy Yard, as Jun. Naval Archt., Jun. Civ. Engr., and (since March 1942) Asst. Civ. Engr.; previously Concrete Inspector, Harza Eng. Co.

OLSON, MYRON ARNOLD, Margarita, Canal Zone. (Age 24) 1941 B.S. in Civ. Eng., N.Dak. Agri. Coll.; Aug. 1941 to date Jun. Engr., Special Eng. Div., Dept. of Operation and Maintenance, The Panama Canal, Gatun, Canal Zone.

ONDERDONK, ARTHUR BRUCE JOSEPH, Portsmouth, N.H. (Age 27) (Claims RCA 1.9) Sept. 1941 to date Asst. Structural Engr., Portsmouth (N.H.) Navy Yard; previously First Asst. Engr. with F. P. Close, Civ. and Cons. Engr., Hartford, Conn.

REHM, LEO FRANK, Milwaukee, Wis. (Age 26) (Claims RCA 2.6) April 1942 to date Asst. Engr., Consoer, Townsend & Quinlan and Kroening Eng. Co., Archt.-Engr.-Mgr., Madison, Wis.; previously with Consoer, Townsend & Quinlan and Battey and Childs, Parsons, Kans.; with Consoer, Townsend & Quinlan, Cons. Engrs., Chicago, Ill.

SACHSE, WILLIAM ROY, Easton, Kans. (Age 23) 1940 B.S., Kans. State Coll.; June 1942 to date Ensign CEC V(S), U.S.N.R.: March 1941 to June 1942 Asst. Inspector of ordnance materiel, St. Louis Ordnance Dist.; previously Jun. Engr., Kansas State Highway Comm.

SCHLENKER, PAUL DORWARD, Canton, Ohio. (Age 30) (Claims RCA 4.6) July 1940 to date with The Union Metal Mfg. Co., on work fo U.S. Navy, U.S. Army, etc.; previously with Raymond Concrete Pile Co. as Chf. Clerk, Supt., etc.

THOMMEN, LOUIS ALOYSIUS, Fort Belvoir, Va. (Age 27) 1940 B.S., U.S. Mil. Acad.; Oct. 1940 to date with U.S. Army, as Commanding Officer, etc., and (at present) Capt.

1942 GRADUATES

UNIV. OF ARK.
(B.S.C.E.) AGE

BOND, CYRUS HUNTINGTON, JR. (21)
KATZER, MAURICE EUGENE (22)

CALIF. INST. TECH.
(B.S. in Civ. Eng.)

ATKINSON, THOMAS GEORGE (22)
COX, RICHARD HORTON (21)
CURTIS, THOMAS GREY (21)
FRANZINI, JOSEPH BERNARD, JR. (21)
GAYER, MARTIN ROGER (21)
JEPHCOTT, DONALD KENNETH (22)
LARSON, ERWIN RAYMOND (21)
LIND, GEORGE WILLIAM, JR. (21)
MCCLAIN, JOHN FRANKLIN, JR. (22)
SKINNER, MELVIN JAMES (22)

UNIV. OF CALIF.
(B.S. in Civ. Eng.)

AARONS, AARON (21)
ADRIAN, GEORGE WASHINGTON (21)
ALLISON, JOHN DANIEL BRADSHAW, JR. (23)
ANDERSON, FREDERICK WILBUR (22)
BATES, CLARENCE WOODROW (23)
BREWER, WILLIAM WALTER, JR. (23)
CAMPING, HAROLD EGBERT (21)
DEGENKOLB, ORIS HERMAN (24)
DENNY, IRVIN VINCENT (22)
DUKE, ROBERT KERR (22)
FACCI, HUGO ANGELO (22)
FULLER, MAURICE EUGENE (23)
GIAMBRONI, JESSIE LOUISE (MISS) (22)
GIMBEL, WILLIAM WOODROW (23)
GLENBOT, EUGENE (22)
GOMMEL, ERNEST WILLIAM, JR. (20)
GRAHAM, RALPH ELWOOD (22)
HENDERSON, JOHN NELSON (20)
HOEFT, JOHN (25)
HOLSTEIN, JOHN JOSEPH (27)
HOWE, ODIA E., JR. (22)
JAMEYSON, BERT (22)
JEONG, GEORGE THEUNG (23)
JEU, HING (21)
JOHNSON, ALBIN WILBERT (22)
KADEL, EDWARD ERNEST (22)
KELLAM, HAROLD ST. CLAIR, JR. (22)
KERR, JOHN NEAL (22)
KIMMELSMAN, BEN STUART (21)
LADD, SCOTT GERALD (21)
LAMMIMAN, GORDON FREDERIC (26)
LEE, SOON (28)
LEHMAN, JEHIEL HERZL (25)
LOUIE, HENRY GIM (22)
MCADAM, DONALD NEER (25)
MAIER, KARL JOSEPH (23)
MEADVILLE, JACK WESTON (23)
MEEHAN, JOHN FRANCIS (21)
MILLER, ALBERT ROBERT (21)
MORISON, WILLIAM HOWARD (21)
MORJIG, EDWARD HAIG (24)
OLSEN, IRVING ELMO (25)
PARKHURST, JOHN DAVID (25)
PETERSON, JEROME LEADHOLM (22)
QAMAR, BANAYOT IBRAHIM (25)
RICHARDS, WELDON LOUIS (31)
ROBINSON, BRICE JENNINGS (23)
SCHULTZ, THEODORE PAUL, JR. (22)
SCHWARTZ, THEODORE (22)
SMITH, ARTHUR BURR, JR. (23)
TOBIAS, FRANCIS BURL (22)
TOIEN, PAUL JOSIAH (26)
WAEGEMANN, AUGUST ERNEST (23)
WICKMAN, DONALD GORDON (26)
WILKINSON, WILLIAM ROBERT (23)
WONG, HARRY GOON (27)
WOODBURY, ROBERT WHALLON (23)

CARNEGIE INST.
(B.S. in C.E.)

MILLER, DAVID HERBERT (21)
O'BRIEN, JOHN TERRANCE (20)
STEWART, CARL MORRELL, JR. (22)
TIBERY, ANGELO JOSEPH GEORGE (24)

CASE SCHOOL OF APPLIED SCI.
(B.S. in San. Eng.)

SMALLWOOD, CHARLES, JR. (22)

COOPER UNION
(B.C.E.)

BIRNBAUM, ARNOLD (24)
BROOKS, GREGORY EDWARD (25)
CHERNOFF, MAX (26)
COFFEY, JOHN JAMES (24)
HAGEDORN, JOHN CARL (27)
LEVENSON, HAROLD EDWARD (21)
LINCER, MAXWELL (23)
MALCHENSON, MARTIN (23)
MARKS, HAROLD (22)
ORLICK, MILTON (22)
SCHEINER, ALFRED (25)
SIELKE, ALAN LEONARD (25)
THAISZ, LOUIS JOSEPH (21)

CORNELL UNIV.
(B.C.E.)

PETERSON, LAWRENCE EUGENE, JR. (21)
SOFAIR, MEIR NESSIM (24)
(Also A.B.)

DARTMOUTH COLL. THAYER SCHOOL OF ENG.
(C.E.)

GUENTHER, JACK GAYLORD (24)
(Also A.B. Dartmouth Coll.)

UNIV. OF DEL.
(B.C.E.)

HUBBARD, DAVID FOSTER, JR. (21)
WHITEMAN, JOSEPH CARR, JR. (22)

UNIV. OF DETROIT
(B.C.E.)

GOODMAN, DAVID (23)
HAFNER, JAMES PETER (25)
HARDY, CALNON LEO, JR. (24)

DUKE UNIV.
(B.S. in C.E.)

GODDARD, JOHN ERVIN, JR. (22)
WELLS, RICHARD BULMER, JR. (21)

UNIV. OF FLA.
(B.C.E.)

CARTER, OLIVER MARTIN, JR. (21)
MONROE, AUGUSTUS CURRIE (23)
TEUTSCH, KURT (21)

GA. SCHOOL TECH.
(B.S. in C.E.)

WRIGHT, CHARLES WILLIAM (23)

HARVARD UNIV.
(M.S.)

NORRIS, JAMES CASPAR, JR. (22)
(Also 1941 B.E., Vanderbilt Univ.

UNIV. OF HAWAII
(B.S. in C.E.)

- Chun, Raymond Keong (21)

UNIV. OF IDAHO
(B.S. in Civ. Eng.)

- Anderson, Merlyn Wesley (23)
- Honey, Francis Edward (27)
- Marden, Daniel Seavey (28)
- Roper, Donald Ross (24)
- Smith, Robert Edward (23)
- Sult, Harry Maurice (26)
- Wren, George Woodrow (22)

UNIV. OF ILL.
(B.S. in C.E.)

- King, Elwyn Harry (22)

IOWA STATE COLL.
(B.S. in C.E.)

- Kisele, Charles Frederick (21)
- Greimann, Victor Everett (24)
- Jenks, Leon Howard (22)
- Jones, Wallace Ray (21)
- Park, Robert Don (21)
- Reid, John Lawrence (21)
- Temple, LaVern Orvill (25)
- Vogel, Harold Ray (31)
- Walker, Jack Edwin (22)
- Wilson, John Merlin (22)

(B.S. in A.E.)

- Moburg, Howard Welby (22)

STATE UNIV. OF IOWA
(B.S in C.E.)

- Duffe, Bernard Harry (21)

THE JOHNS HOPKINS UNIV.
(B.E.)

- Diver, Charles Alvin (20)
- Fisher, Gordon Page (20)
- Lego, Arthur Burkett (22)
- Roth, Louis Herman, Jr. (21)
- Tallarico, Albi Kimball (22)
- Webster, Walter Edelen, Jr. (21)

UNIV. OF KY.
(B.S.C.E.)

- Stewart, Thomas Marion (23)
- Terrell, George Williams (20)

LEHIGH UNIV.
(B.S. in C.E.)

- Brooks, William Alexander (22)
- McGonigle, John Leo, Jr. (21)
- Mark, Sandor (21)
- Muhlhausen, Edgar Kirton (23)

LA. STATE UNIV.
(B.S. in C.E.)

- Braswell, Andrew Melvin, Jr. (23)
- McElhannon, William Andrew (23)
- Norckauer, Heber Regal (20)

MANHATTAN COLL.
(B.C.E.)

- Arkins, John Joseph (21)
- Cummings, Warren George (21)
- Devereux, Thomas James (20)
- Fawls, James Francis (20)
- Hahn, Frank Joseph (22)
- Iadavaia, Vincent Anthony (22)
- Keyes, Raymond Joseph (21)
- Lestchuk, William (20)
- Levanti, Arsenio (25)
- McAuley, John Dennis Joseph (21)
- Peacock, Kenneth Allen (22)

MARQUETTE UNIV.
(B.C.E.)

- Madden, Ralph Joseph (22)
- Toy, Alfred Moy (24)

MASS. INST. TECH.
(S.M.)

- Mejia, Hernando (24)
  (Also 1939 C.E. Universidad Nacional, Bogota, Colombia.)

UNIV. OF MINN.
(B.C.E.)

- Dahlgren, Charles Emmett (24)
- Kaercher, William Charles, Jr. (24)
- Nolan, Jack Smith (23)
- Schmidt, Henry Byrnes (22)
- Shimer, Roy (25)
- Vodonick, Emil John Fierst (23)

MISS. STATE COLL.
(B.S. in C.E.)

- Bradford, Lewis Pitts (25)
- Cook, Leland Blanchard (22)
- Filgo, William Ward (22)
- Leech, Ralph Hugh (23)

UNIV. OF MISS.
(B.S.C.E.)

- White, John William (24)

UNIV. OF MO.
(B.S. in Civ. Eng.)

- Bolton, Willard Riley (25)
- Fienup, Kenneth Leroy (20)
- McDaniel, Robert Ray (22)
- Mitchell, Maurice Dale (21)
- Noel, Jim Stribling (24)
- Reno, James Noland (23)
- Shumaker, Willis Leroy (26)
- Sprout, Deane Orland (26)
- Waldram, George Johnson, Jr. (22)
- Weiss, Harold (24)

N.MEX. STATE COLL.
(B.S. in C.E.)

- Magruder, Byron Randel (21)
- Maverty, James Ezell (25)

COLL. OF CITY OF N.Y.
(B.C.E.)

- Gilbert, Joseph (21)
- Titunik, Joseph Mathias (21)

N. Y. UNIV.
(B.C.E.)

- Greenfeld, Albert (22)
- Landsman, Jerome Joel (21)

N.DAK. AGRI. COLL.
(B.S. in C.E.)

- Bergeson, Ernest Bernard (23)
- Schaetzel, Robert Allyn (21)

NORTHEASTERN UNIV.
(B.S. in C.E.)

- Boutelle, Warren Tallmadge (23)
- Brown, Roger Allan (22)
- Caputi, Joseph John (25)
- Crossley, Norman Shepherd (25)
- Freeman, Dean (22)
- Grover, John Theodore (24)
- Henderson, Robert Dawson (23)
- Ketchen, Ernest Butler (24)
- Landman, Saul (22)
- Lariviere, Frank John (24)
- Marks, Murray (22)
- Noonan, Hugh Joseph (22)
- Serafini, Lelio (23)
- Smith, Elmer Edward (22)
- Sutliff, Richard Dewitt (22)
- Swift, Charles Beal, Jr. (22)
- Tidd, Ellsworth Hartley (22)

UNIV. OF N.DAK.
(B.S. in C.E.)

- Fox, Kendall Christian (22)
- Nielsen, Jens Peter (29)

OHIO NORTHERN UNIV.
(B.S. in C.E.)

- Opdycke, Alfred Leonard (24)

OHIO STATE UNIV.
(B.C.E.)

- Bradstock, Norman Edgar (22)

ORE. STATE COLL.
(B.S. in C.E.)

- Barber, Thomas Woodrow (21)
- Bixby, Deane Francis (21)
- Blair, Jay William (24)
- Brockmeier, Glenn Charles (21)
- Brockschink, Frank Roy, Jr. (21)
- Donahey, Michael Harold (33)
- Gerlach, Norman William (23)
- Huff, Douglas Elliot (27)
- Iverson, DeForest Dale (25)
- Merrifield, John Turner (22)
- Nelson, Melvin Benard (26)
- Olson, Arthur Eugene (25)
- Osborne, Herbert Tilden (22)
- Palmer, Raymond Dewey, Jr. (22)
- Riley, Edward Warwick (24)
- Sommerville, Thomas (25)
- Steele, Charles Clifton (23)
- White, Douglas Conyne (23)
- Wilson, Robert Edward (21)
- Wilson, Wilbur Kenneth (21)

PA. STATE COLL.
(B.S. in C.E.)

- Georgi, Charles Otto (22)
- Gokbert, Walter Glenn (25)
- Hablett, Harold Wesley (21)
- Harris, Thomas Jefferson, Jr. (22)
- Hart, William Edward (23)
- Himmelberger, Ralph Hetrick (22)
- Laushey, Louis McNeal (25)
- Morris, Robert Kessler (22)

RENS. POL. INST.
(B.C.E.)

- Bassar, Nicholas, Jr. (26)

R.I. STATE COLL.
(B.S. in Civ. Eng.)

- Strong, Willis Edgar (23)

RICE INST.
(B.S. in Civ. Eng.)

- Britton, John Claude (26)

RUTGERS UNIV.
(B.S. in San. Eng.)

- Kempson, Norman William (22)

UNIV. OF SANTA CLARA
(B.C.E.)

- Boyer, John Otis (22)
- Bressani, Richard Victor (24)
- Nash, Francis Charles (22)

UNIV. OF SO. CALIF.
(B.S. in C.E.)

- Hallin, Norman Gustav (22)
- Kastel, Jerome Marvin (25)
- Reid, George Frederick, Jr. (24)

S.DAK. STATE COLL.
(B.S. in Civ. Eng.)

- Salmon, John Charles (20)

SO.DAK. STATE SCHOOL OF MINES
(B.S. in Civ. Eng.)

- Doerr, Dale Delmar (21)
- Johnson, Lyle Jerome (23)
- Miller Wilbur Harold (25)
- Vobejda, William Frank (23)
- Wall, Halbert Lesly (23)

SO. METHODIST UNIV.
(B.S. in C.E.)

- Halford, Marion Lee (23)
- Manning, William Francis (21)
- O'Rourke, George Paul Jr. (23)

STANFORD UNIV.
(C.E.)

- Fitzmaurice, Robert Melvin (24)
  (Also 1940 A.B. in Eng.)
- Scherrer, Robert Elmer (25)
  (Also 1940 B.S.C.E., Colorado, Univ.)

(A.B. in Eng.)

- Arena, Vincent Anthony (22)
- Burmeister, Sumner Fred (23)
- Fredrickson, Bernard Vernon (21)
- Parker, John Bernard (21)
- Witt, Harry Robert (23)

UNIV. OF TENN.
(B.S. in Civ. Eng.)

- Fox, William Eddy (23)
- Reager, George Deglan (26)
- Thomas, Clarence Merald (24)

TUFTS COLL.
(B.S. in C.E.)

- Vitale, Ralph Joseph (21)
- Wilson, Donald Smith (21)

UNIV. OF VA.
(B.C.E.)

- Kinnier, Henry Lee (26)
- Livesay, Ernest Boyd (24)
- O'Grince, Sylvester Henry (24)
- Schumaker, David Wilson (23)

WASH. STATE COLL.
(B.S. in Civ. Eng.)

- Sitts, Harold Frederick (22)

WASHINGTON UNIV.
(B.S. in C.E.)

- Brooks, Joseph Boyd (20)
- Harting, William Mollet (22)
- Reitz, Henry Matthew (20)

W.VA. UNIV.
(B.S. in Civ. Eng.)

- Carter, Jack Warren (22)

UNIV. OF WIS.
(B.S.C.E.)

- Bertle, Frederick Albert (22)
- Ingersoll, Alfred Cajori (22)
- Resnick, Sol Donald (24)
- Warzyn, Willard Waldo (24)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

No. 8

(26)

(23)

(26)

(22)

RA

(22)
(24)
(22)

(22)
(25)
(24)

(20)

MINES

(21)
(23)
(25)
(23)
(23)

(23)
(21)
(23)

(24)

(25)

(22)
(23)
(21)
(21)
(23)

(23)
(26)
(24)

(21)
(21)

(26)
(24)
(24)
(23)

(22)

(20)
(22)
(20)

(22)

(22)
(22)
(24)
(24)

applica-
after the